R&S®FSW-K10x (LTE Uplink)
LTE Uplink Measurement Application
User Manual

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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual applies to the following R&S®FSW models with firmware version 2.22 and higher:

- R&S®FSW8 (1312.8000K08)
- R&S®FSW13 (1312.8000K13)
- R&S®FSW26 (1312.8000K26)
- R&S®FSW43 (1312.8000K43)
- R&S®FSW50 (1312.8000K50)
- R&S®FSW67 (1312.8000K67)
- R&S®FSW85 (1312.8000K85)

The following firmware options are described:

- R&S FSW-K101 (LTE FDD UL) (1313.1551.02)
- R&S FSW-K103 (LTE MIMO UL) (1313.2487.02)
- R&S FSW-K105 (LTE TDD UL) (1313.1580.02)

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The following abbreviations are used throughout this manual: R&S®FSW is abbreviated as R&S FSW.

Contents

1 Welcome to the LTE Measurement Application

The R&S FSW-K101, -K103 and -K105 are firmware applications that add functionality to perform measurements on LTE signals according to the 3GPP standard to the R&S FSW.

This user manual contains a description of the functionality that the application provides, including remote control operation. Functions that are not discussed in this manual are the same as in the Spectrum application and are described in the R&S FSW User Manual. The latest versions of the manuals are available for download at the product homepage.

http://www2.rohde-schwarz.com/product/FSW.html.

1.1 Overview of the LTE Applications

You can equip the R&S FSW with one or more LTE applications. Each of the applications provides functionality for specific measurement tasks.

R&S FSW-K100

The R&S FSW-K100 is designed to perform measurements on LTE FDD signals on the downlink.

The application has the following features:

- Basic signal characteristics (like frequency, channel bandwidth or cyclic prefix).
- Demodulation and configuration of the PDSCH transmitted over a single antenna and without precoding functionality.
- Characteristics of the Synchronization and Reference signals.
- Consideration of various control channels in the measurement (for example the PBCH or the PPDCH).
- Analysis of individual antennas in a MIMO setup.
- Tools to refine and filter the measurement results.
- Various result displays that show the measured signal characteristics in a diagram or a numeric result table.
- Available measurements: EVM, ACLR and SEM.

R&S FSW-K101

The R&S FSW-K101 is designed to perform measurements on LTE FDD signals on the uplink.

The application has the following features:

- Basic signal characteristics (like frequency, channel bandwidth or cyclic prefix).
- Demodulation and configuration of the subframes transmitted over a single antenna.
- Characteristics of the Demodulation and Sounding Reference signals.
- Consideration of the PUSCH, PUCCH and PRACH channels.
- Analysis of individual antennas in a MIMO setup.
- Tools to refine and filter the measurement results.
- Various result displays that show the measured signal characteristics in a diagram or a numeric result table.
- Available measurements: EVM, ACLR and SEM.

R&S FSW-K102

The R&S FSW-K102 is designed to perform measurements on LTE Advanced systems and MIMO systems on the downlink.

Note that this application only works in combination with either R&S FSW-K100 or -K104.

The application has the following features:

- Simultaneous (or consecutive) capture and subsequent analysis of the data streams of several antennas.
- Control of several analyzers required for MIMO measurements.
- Consideration of the Precoding schemes defined in the 3GPP standard.
- Support of Carrier Aggregation.
- Measurements on Multimedia Broadcast Single Frequency Networks (MBSFNs).
- Additional measurements: Time Alignment Error, Multi-Carrier ACLR, Cumulative ACLR and Multi-SEM.

R&S FSW-K103

The R&S FSW-K103 is designed to perform measurements on LTE Advanced systems on the uplink.

Note that this application only works in combination with either R&S FSW-K101 or -K105.

The application has the following features:

- Simultaneous (or consecutive) capture and subsequent analysis of the data streams of several antennas.
- Control of several analyzers required for MIMO measurements.
- Consideration of the enhanced PUSCH and PUCCH characteristics.
- Support of Carrier Aggregation.
- Additional measurements: Time Alignment Error, Multi-Carrier ACLR and Multi SEM.

R&S FSW-K104

The R&S FSW-K104 is designed to perform measurements on LTE TDD signals on the downlink.

The features are basically the same as in the R&S FSW-K100 with additional features that allow you to configure TDD subframes. It also provides tools to perform On/Off Power measurements.

R&S FSW-K105

The R&S FSW-K105 is designed to perform measurements on LTE TDD signals on the uplink.

The features are basically the same as in the R&S FSW-K101 with additional features that allow you to configure TDD subframes.

1.2 Installation

Find detailed installing instructions in the Getting Started or the release notes of the R&S FSW.

1.3 Starting the LTE Measurement Application

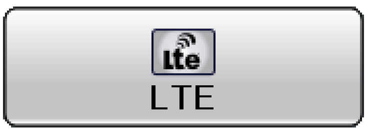
The LTE measurement application adds a new application to the R&S FSW.

To activate the application

1. Press the MODE key on the front panel of the R&S FSW.

   A dialog box opens that contains all operating modes and applications currently available on your R&S FSW.

2. Select the "LTE" item.

   The R&S FSW opens a new measurement channel for the LTE measurement application.

LTE PC software and LTE measurement application

If you are using the EUTRA/LTE PC Software in combination with an R&S FSW, the "Mode" dialog box also contains a item for this software. It is labeled "LTE Software" and opens the PC software on the R&S FSW.

A comprehensive description of the functionality of this software is provided in a separate manual available for download on the internet.

The measurement is started immediately with the default settings. It can be configured in the "Overview" dialog box, which is displayed when you select the "Overview" softkey from any menu.

For more information see chapter 4, "Configuration", on page 41.

1.4 Understanding the Display Information

The following figure shows a measurement diagram during analyzer operation. All different information areas are labeled. They are explained in more detail in the following sections.

1 = Toolbar
2 = Channel bar
3 = Diagram header
4 = Result display
5 = Subwindows (if more than one MIMO data stream is displayed at the same time)
5 = Status bar
6 = Softkeys

MSRA operating mode

In MSRA operating mode, additional tabs and elements are available. A colored background of the screen behind the measurement channel tabs indicates that you are in MSRA operating mode. Frequency sweep measurements are not available in MSRA operating mode.

For details on the MSRA operating mode see the R&S FSW MSRA User Manual.

Channel bar information

In the LTE measurement application, the R&S FSW shows the following settings:

Table 1-1: Information displayed in the channel bar in the LTE measurement application

Ref Level	Reference level
Att	Mechanical and electronic RF attenuation
Freq	Frequency
Mode	LTE standard
MIMO	Number of Tx and Rx antennas in the measurement setup
Capture Time	Signal length that has been captured
Frame Count	Number of frames that have been captured
Selected Slot	Slot considered in the signal analysis
Selected Subframe	Subframe considered in the signal analysis

In addition, the channel bar also displays information on instrument settings that affect the measurement results even though this is not immediately apparent from the display of the measured values (e.g. transducer or trigger settings). This information is displayed only when applicable for the current measurement. For details see the R&S FSW Getting Started manual.

Window title bar information

The information in the window title bar depends on the result display.

The "Constellation Diagram", for example, shows the number of points that have been measured.

Status bar information

Global instrument settings, the instrument status and any irregularities are indicated in the status bar beneath the diagram. Furthermore, the progress of the current operation is displayed in the status bar.

Regarding the synchronization state, the application shows the following labels.

- Sync OK
  The synchronization was successful. The status bar is green.
- Sync Failed
  The synchronization was not successful. The status bar is red.
  There can be three different synchronization errors.
  - Sync Failed (Cyclic Prefix): The cyclic prefix correlation failed.
  - Sync Failed (P-SYNC): The P-SYNC correlation failed.
  - Sync Failed (S-SYNC): The S-SYNC correlation failed.

2 Measurements and Result Displays

The LTE measurement application measures and analyzes various aspects of an LTE signal.

It features several measurements and result displays. Measurements represent different ways of processing the captured data during the digital signal processing. Result displays are different representations of the measurement results. They may be diagrams that show the results as a graph or tables that show the results as numbers.

2.1 Selecting Measurements

► Press the MEAS key.

The application opens a dialog box that contains several buttons.
Each button represents a set of result displays that thematically belong together and that have a particular display configuration. If these predefined display configurations do not suit your requirements you can add or remove result displays as you like. For more information about selecting result displays see chapter 2.2, "Selecting Result Displays", on page 11.

Depending on the button you select, the application changes the way the R&S FSW captures and processes the raw signal data.

- When you select "EVM" or "Time Alignment Error", the application processes the I/Q data of the signal. For more information on available I/Q result displays see chapter 2.5, "I/Q Measurements", on page 13.
  When you select one of the result displays available for I/Q measurements, you can combine the result displays available for I/Q measurements in any way.
- When you select "Channel Power ACLR" or "Spectrum Emission Mask", the application performs a frequency sweep. For more information see chapter 2.7, "Frequency Sweep Measurements", on page 27.
  When you select one of the frequency sweep measurements, you can combine the result displays available for the frequency sweep measurements in any way. Note that you can not display the ACLR and SEM at the same time.

Remote command:

`CONFigure[:LTE]:MEASurement` on page 145

2.2 Selecting Result Displays

► Select the icon in the toolbar or press the "Display Config" softkey in the "Measurement" menu.

The application enters the SmartGrid configuration mode.
For more information on the SmartGrid functionality see the R&S FSW Getting Started.

In the default state of the application, it shows several conventional result displays.

- Capture Buffer
- EVM vs Carrier
- Power Spectrum
- Result Summary
- Constellation Diagram

From that predefined state, add and remove result displays as you like from the evaluation bar.

Remote command:

`LAYout:ADD[:WINDow]?` on page 103

Note that you can customize the contents of some numerical result displays. For more information see chapter 5.1, "Configuring Tables / Numerical Results", on page 86.

MIMO measurements

When you capture more than one data stream, each result display is made up out of several tabs.

The first tab shows the results for all data streams. The other tabs show the results for each individual data stream. By default, the tabs are coupled to one another - if you select a particular data stream in one display, the application also selects this data stream in the other result displays (see Subwindow Coupling).

The number of tabs depends on the number of data streams.

2.3 Performing Measurements

By default, the application measures the signal continuously. In "Continuous Sweep" mode, the application captures and analyzes the data again and again. The amount of data depends on the capture time (I/Q measurements) or the sweep time (frequency sweep measurements). In "Single Sweep" mode, the application stops measuring after it has captured the data once. The amount of data again depends on the capture time or the sweep time.

You can also repeat a measurement based on the data that has already been captured with the "Refresh" function. This is useful if you want to apply different modulation settings to the same I/Q data, for example.

For more information see the documentation of the R&S FSW.

2.4 Selecting the Operating Mode

The LTE application is supported by the Multi Standard Radio Analyzer (MSRA).

► Press the MODE key.

► Select the "Multi-Standard Radio Analyzer Tab".

The R&S FSW enters MSRA mode.

The MSRA mode supports all I/Q measurements and result displays available with the LTE application, except the frequency sweep measurements (SEM and ACLR).

In MSRA operating mode, only the MSRA Master actually captures data. The application receives an extract of the captured data for analysis, referred to as the **application data**. The application data range is defined by the same settings used to define the signal capture in Signal and Spectrum Analyzer mode. In addition, a capture offset can be defined, i.e. an offset from the start of the captured data to the start of the analysis interval.

If a signal contains multiple data channels for multiple standards, separate applications are used to analyze each data channel. Thus, it is of interest to know which application is analyzing which data channel. The MSRA Master display indicates the data covered by each application by vertical blue lines labeled with the application name. The blue lines correspond to the channel bandiwdth which is variable in case of LTE signals.

However, the individual result displays of the application need not analyze the complete data range. The data range that is actually analyzed by the individual result display is referred to as the **analysis interval**.

The analysis interval is automatically determined according to the Capture Time you have defined. The analysis interval can not be edited directly in the LTE application, but is changed automatically when you change the evaluation range. The currently used analysis interval (in seconds, related to capture buffer start) is indicated in the window header for each result display.

A frequent question when analyzing multi-standard signals is how each data channel is correlated (in time) to others. Thus, an analysis line has been introduced. The analysis line is a common time marker for all MSRA applications. It can be positioned in any MSRA application or the MSRA Master and is then adjusted in all other applications. Thus, you can easily analyze the results at a specific time in the measurement in all applications and determine correlations.

If the marked point in time is contained in the analysis interval of the application, the line is indicated in all time-based result displays, such as time, symbol, slot or bit diagrams. By default, the analysis line is displayed, however, it can be hidden from view manually. In all result displays, the "AL" label in the window title bar indicates whether or not the analysis line lies within the analysis interval or not:

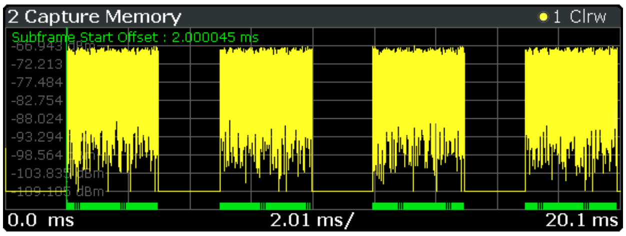
- **orange "AL"**: the line lies within the interval
- **white "AL"**: the line lies within the interval, but is not displayed (hidden)
- **no "AL"**: the line lies outside the interval

For details on the MSRA operating mode see the R&S FSW MSRA documentation.

2.5 I/Q Measurements

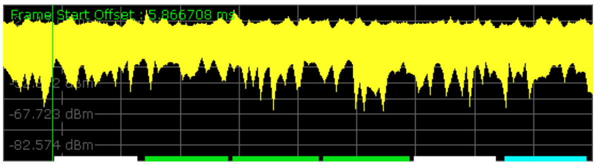
Capture Buffer

The Capture Buffer result display shows the complete range of captured data for the last data capture. The x-axis represents time. The maximum value of the x-axis is equal to the Capture Time. The y-axis represents the amplitude of the captured I/Q data in dBm (for RF input).



A green vertical line at the beginning of the green bar in the Capture Buffer display marks the subframe start. Additionally, the diagram contains the "Start Offset" value. This value is the time difference between the subframe start and capture buffer start.

When you zoom into the diagram, you will see that the bar may be interrupted at certain positions. Each small bar indicates the useful parts of the OFDM symbol.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,CBUF
Querying results: TRACe:DATA?
Querying the subframe start offset: `FETCh:SUMMary:TFRame?` on page 133

EVM vs Carrier
Starts the EVM vs Carrier result display.

This result display shows the Error Vector Magnitude (EVM) of the subcarriers. With the help of a marker, you can use it as a debugging technique to identify any subcarriers whose EVM is too high.

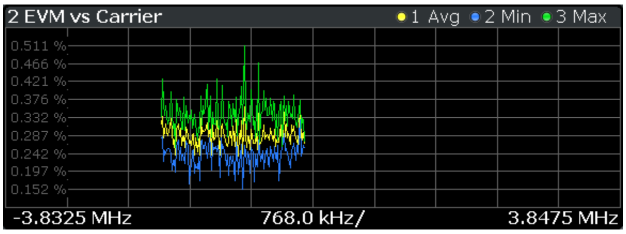
The results are based on an average EVM that is calculated over the resource elements for each subcarrier. This average subcarrier EVM is determined for each analyzed slot in the capture buffer.

If you analyze all slots, the result display contains three traces.

- Average EVM
  This trace shows the subcarrier EVM averaged over all slots.
- Minimum EVM
  This trace shows the lowest (average) subcarrier EVM that has been found over the analyzed slots.
- Maximum EVM
  This trace shows the highest (average) subcarrier EVM that has been found over the analyzed slots.

If you select and analyze one slot only, the result display contains one trace that shows the subcarrier EVM for that slot only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 87

The x-axis represents the center frequencies of the subcarriers. On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,EVCA
Querying results: TRACe:DATA?

EVM vs Symbol
Starts the EVM vs Symbol result display.

This result display shows the Error Vector Magnitude (EVM) of the OFDM symbols. You can use it as a debugging technique to identify any symbols whose EVM is too high.

The results are based on an average EVM that is calculated over all subcarriers that are part of a particular OFDM symbol. This average OFDM symbol EVM is determined for all OFDM symbols in each analyzed slot.

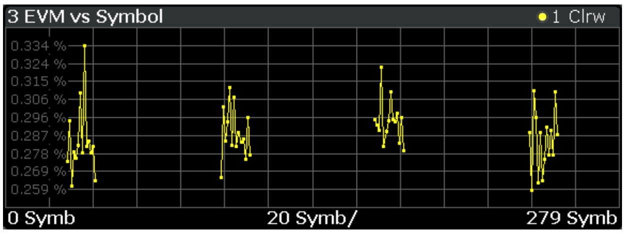
If you analyze all subframes, the result display contains three traces.

- Average EVM
  This trace shows the OFDM symbol EVM averaged over all slots.
- Minimum EVM
  This trace shows the lowest (average) OFDM symbol EVM that has been found over the analyzed slots.
- Maximum EVM
  This trace shows the highest (average) OFDM symbol EVM that has been found over the analyzed slots.

If you select and analyze one slot only, the result display contains one trace that shows the OFDM symbol EVM for that slot only. Average, minimum and maximum values in that case are the same. For more information see "Subframe Selection" on page 87

The x-axis represents the OFDM symbols, with each symbol represented by a dot on the line. The number of displayed symbols depends on the Subframe Selection and the length of the cyclic prefix. Any missing connections from one dot to another mean that the R&S FSW could not determine the EVM for that symbol. In case of TDD signals, the result display does not show OFDM symbols that are not part of the measured link direction.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,EVSY
Querying results: TRACe:DATA?

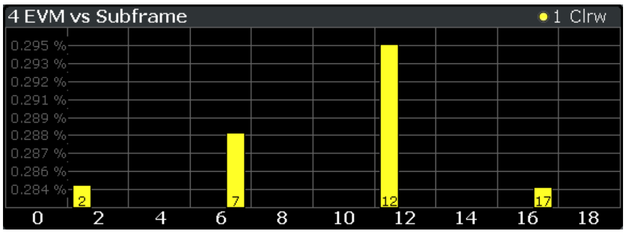
EVM vs Subframe
Starts the EVM vs Subframe result display.

This result display shows the Error Vector Magnitude (EVM) for each subframe. You can use it as a debugging technique to identify a subframe whose EVM is too high.

The result is an average over all subcarriers and symbols of a specific subframe.

The x-axis represents the subframes, with the number of displayed subframes being 10.

On the y-axis, the EVM is plotted either in % or in dB, depending on the EVM Unit.



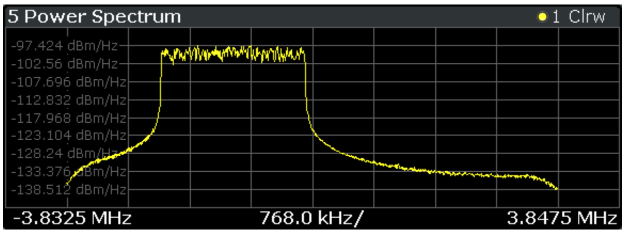
Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,EVSU
Querying results: TRACe:DATA?

Power Spectrum
Starts the Power Spectrum result display.

This result display shows the power density of the complete capture buffer in dBm/Hz. The displayed bandwidth depends on bandwidth or number of resource blocks you have set.

For more information see "Channel Bandwidth / Number of Resource Blocks" on page 46.

The x-axis represents the frequency. On the y-axis the power level is plotted.



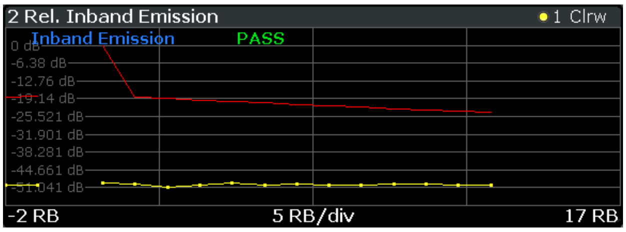
Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,PSPE
Querying results: TRACe:DATA?

Inband Emission
Starts the Inband Emission result display.

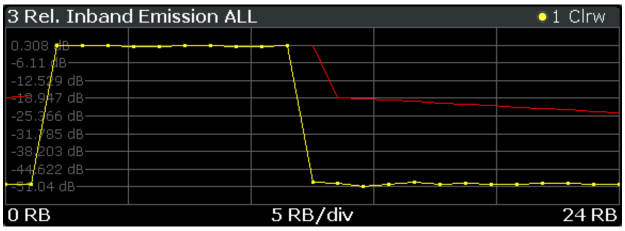
This result display shows the relative power of the unused resource blocks (yellow trace) and the inband emission limit lines (red trace) specified by the LTE standard document 3GPP TS36.101.

The measurement is evaluated over the currently selected slot in the currently selected subframe. The currently selected subframe depends on your selection.

Note that you have to select a specific subframe and slot to get valid measurement results.



You can also display the inband emissions for the allocated resource block in addition to the unused resource blocks when you select the Inband Emissions All result display.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,IE
Selecting the result display: LAY:ADD ? '1',LEFT,IEA
Querying results: TRACe:DATA?

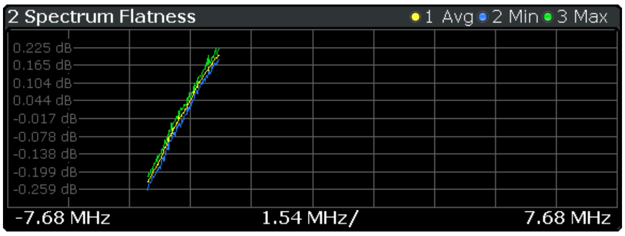
Spectrum Flatness
Starts the Spectrum Flatness result display.

This result display shows the relative power offset caused by the transmit channel.

The measurement is evaluated over the currently selected slot in the currently selected subframe.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the channel flatness is plotted in dB.

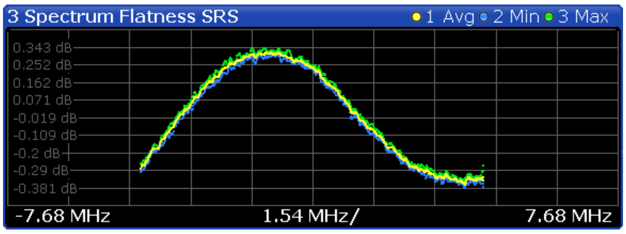


Note that the limit lines are only displayed if you match the Operating Band to the center frequency. Limits are defined for each operating band in the standard. The shape of the limit line is different when "Extreme Conditions" on page 48 are on.

Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,SFL
Querying results: TRACe:DATA?

Spectrum Flatness SRS
The Spectrum Flatness SRS display shows the amplitude of the channel transfer function based on the sounding reference signal.

The measurement is evaluated over the currently selected slot in the currently selected subframe. The slot and subframe selection may be changed in the general settings.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,SFSR
Querying results: TRACe:DATA

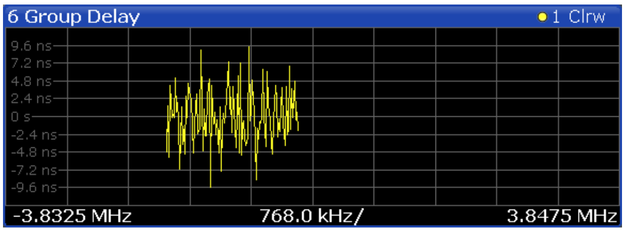
Channel Group Delay
Starts the Channel Group Delay result display.

This result display shows the group delay of each subcarrier.

The measurement is evaluated over the currently selected slot in the currently selected subframe.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the group delay is plotted in ns.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,GDEL
Querying results: TRACe:DATA?

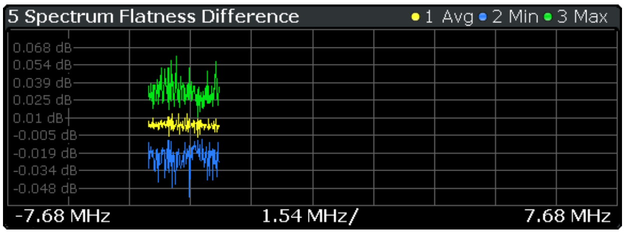
Spectrum Flatness Difference
Starts the Spectrum Flatness Difference result display.

This result display shows the level difference in the spectrum flatness result between two adjacent physical subcarriers.

The measurement is evaluated over the currently selected slot in the currently selected subframe.

The currently selected subframe depends on your selection.

The x-axis represents the frequency. On the y-axis, the power is plotted in dB.



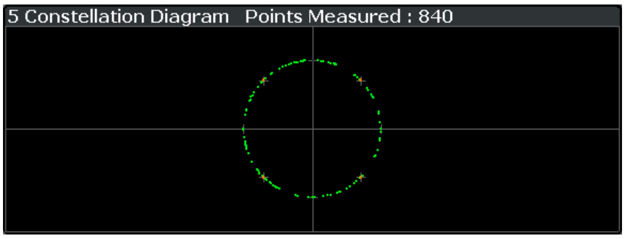
Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,SFD
Querying results: TRACe:DATA?

Constellation Diagram

Starts the Constellation Diagram result display.

This result display shows the inphase and quadrature phase results and is an indicator of the quality of the modulation of the signal.

In the default state, the result display evaluates the full range of the measured input data. You can filter the results by changing the evaluation range.



The constellation diagram also contains information about the current evaluation range. In addition, it shows the number of points that are displayed in the diagram.

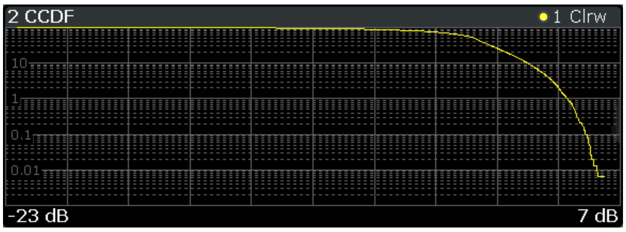
Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,CONS
Querying results: TRACe:DATA?

CCDF

Starts the Complementary Cumulative Distribution Function (CCDF) result display.

This result display shows the probability of an amplitude exceeding the mean power. For the measurement, the complete capture buffer is used.

The x-axis represents the power relative to the measured mean power. On the y-axis, the probability is plotted in %.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,CCDF
Querying results: TRACe:DATA?

Allocation Summary
Starts the Allocation Summary result display.

This result display shows the results of the measured allocations in tabular form.

4 Allocation Summary

Sub-Frame	Allocation ID	No. of RBs	Offset RB	Modulation	Power [dBm]	EVM [%]
2	PUSCH	10	2	QPSK	-30.020	0.285
	DMRS PUSCH			CAZAC	-30.020	0.292
7	PUSCH	10	2	QPSK	-30.019	0.287
	DMRS PUSCH			CAZAC	-30.017	0.297

The rows in the table represent the allocations. A set of allocations form a subframe. The subframes are separated by a dashed line. The columns of the table contain the following information:

- **Subframe**
  Shows the subframe number.
- **Allocation ID**
  Shows the type / ID of the allocation.
- **Number of RB**
  Shows the number of resource blocks assigned to the corresponding allocation.
- **Offset RB**
  Shows the resource block offset of the allocation.
- **Modulation**
  Shows the modulation type.
- **Power**
  Shows the power of the allocation in dBm.
- **EVM**
  Shows the EVM of the allocation. The unit depends on your selection.

Note: Contents of the Allocation Summary
The number of columns shown in the Allocation Summary is variable. To add or remove a column, click on the header row of the table *once*. The application opens a dialog box to select the columns which you'd like to display.

Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,ASUM
Querying results: TRACe:DATA?

Bit Stream
Starts the Bit Stream result display.

This result display shows the demodulated data stream for each data allocation. Depending on the Bit Stream Format, the numbers represent either bits (bit order) or symbols (symbol order).

Selecting symbol format shows the bit stream as symbols. In that case the bits belonging to one symbol are shown as hexadecimal numbers with two digits. In the case of bit format, each number represents one raw bit.

Symbols or bits that are not transmitted are represented by a "-".

If a symbol could not be decoded because the number of layers exceeds the number of receive antennas, the application shows a "#" sign.

1 Bit Stream

Sub-Frame	Allocation ID	Code-word	Modulation	Symbol Index	Bi
2	PUSCH	1/1	QPSK	0	02 02 00 03 02 01 02
2	PUSCH	1/1	QPSK	16	01 01 02 00 00 00 03
2	PUSCH	1/1	QPSK	32	00 02 03 00 03 03 02
2	PUSCH	1/1	QPSK	48	00 02 01 02 03 02 02
2	PUSCH	1/1	QPSK	64	01 01 00 03 03 01 01
2	PUSCH	1/1	QPSK	80	00 02 01 03 03 03 03

The table contains the following information:

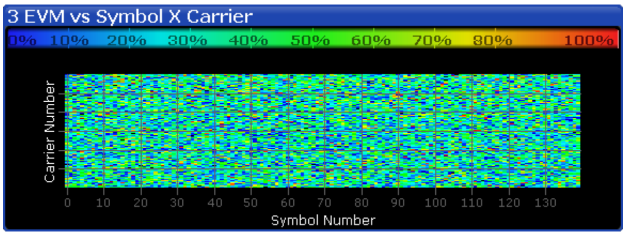
- **Subframe**
  Number of the subframe the bits belong to.
- **Allocation ID**
  Channel the bits belong to.
- **Codeword**
  Code word of the allocation.
- **Modulation**
  Modulation type of the channels.
- **Symbol Index** or **Bit Index**
  Shows the position of the table row's first bit or symbol within the complete stream.
- **Bit Stream**
  The actual bit stream.

Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,BSTR
Querying results: TRACe:DATA?

EVM vs Sym x Carr

The EVM vs Symbol x Carrier shows the EVM for each carrier in each symbol.

The horizontal axis represents the symbols. The vertical axis represents the carriers. Different colors in the diagram area represent the EVM. The color map for the power levels is provided above the diagram area.

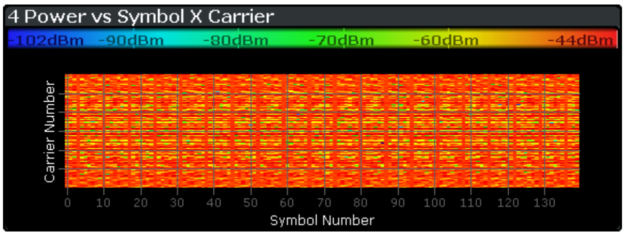


Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,EVSC
Querying results: TRACe:DATA?

Power vs Symbol x Carrier

The Power vs Symbol x Carrier shows the power for each carrier in each symbol.

The horizontal axis represents the symbols. The vertical axis represents the carriers. Different colors in the diagram area represent the power. The color map for the power levels is provided above the diagram area.



Remote command:
Selecting the result display: LAY:ADD ? '1',LEFT,PVSC
Querying results: TRACe:DATA?

Result Summary
The Result Summary shows all relevant measurement results in numerical form, combined in one table.

Remote command:

LAY:ADD ? '1',LEFT,RSUM

Contents of the result summary

4 Result Summary

Frame Results 30/30	Mean	Limit	Max	Min
EVM PUSCH QPSK (%)	0.30	17.50		
EVM PUSCH 16QAM (%)		12.50		
EVM DMRS PUSCH QPSK (%)	0.35	17.50		
EVM DMRS PUSCH 16QAM (%)		12.50		
EVM PUCCH (%)		17.50		
EVM DMRS PUCCH (%)		17.50		
Results for Selection	**Subframe(s) ALL**	**Slot(s) ALL**	**Frame Results 30/30**	
EVM All (%)	0.29		0.30	0.28
EVM Phys. Channel (%)	0.29		0.30	0.27
EVM Phys. Signal (%)	0.28		0.31	0.25
Frequency Error (Hz)	-26.65		-26.05	-27.29
Sampling Error (ppm)				
IQ Offset (dB)	-67.10		-63.11	-74.13
IQ Gain Imbalance (dB)				
IQ Quadrature Error (°)				
Power (dBm)	-30.02		-30.02	-30.02
Crest Factor (dB)	5.76		6.21	5.35

4 Result Summary

3GPP EVM Results	Mean	Limit	Max	Min
EVM PRACH (%)	0.22	17.50		
Results for Selection	**Preamble ALL**		**Preamble Count 2/2**	
EVM All (%)	0.22		0.22	0.22
Frequency Error (Hz)	-26.91		-26.77	-27.04
Sampling Error (ppm)				
IQ Offset (dB)	-127.79		-127.70	-127.88
IQ Gain Imbalance (dB)				
IQ Quadrature Error (°)				
Power (dBm)	-26.59		-26.59	-26.59
Crest Factor (dB)	4.50		4.51	4.49

The table is split in two parts. The first part shows results that refer to the complete frame. It also indicates limit check results where available. The font of 'Pass' results is green and that of 'Fail' results is red.

Note that the contents of the table depend on whether you are measuring in PUCCH/PUSCH or PRACH analysis mode. For more information see "Analysis Mode" on page 78.

In addition to the red font, the application also puts a red star (* 25.60) in front of failed results.

Note: The EVM results on a frame level (first part of the table) are calculated as defined by 3GPP at the edges of the cyclic prefix.
The other EVM results (lower part of the table) are calculated at the optimal timing position in the middle of the cyclic prefix.

Because of inter-symbol interference, the EVM calculated at the edges of the cyclic prefix is higher than the EVM calculated in the middle of the cyclic prefix.

EVM PUSCH QPSK	Shows the EVM for all QPSK-modulated resource elements of the PUSCH channel in the analyzed frame. `FETCh:SUMMary:EVM:USQP[:AVERage]?` on page 128
EVM PUSCH 16QAM	Shows the EVM for all 16QAM-modulated resource elements of the PUSCH channel in the analyzed frame. `FETCh:SUMMary:EVM:USST[:AVERage]?` on page 128
EVM PUSCH 64QAM	Shows the EVM for all 64QAM-modulated resource elements of the PUSCH channel in the analyzed frame. `FETCh:SUMMary:EVM:USSF[:AVERage]?` on page 128
EVM DRMS PUSCH QPSK	Shows the EVM of all DMRS resource elements with QPSK modulation of the PUSCH in the analyzed frame. `FETCh:SUMMary:EVM:SDQP[:AVERage]?` on page 126
EVM DRMS PUSCH 16QAM	Shows the EVM of all DMRS resource elements with 16QAM modulation of the PUSCH in the analyzed frame. `FETCh:SUMMary:EVM:SDST[:AVERage]?` on page 127
EVM DRMS PUSCH 64QAM	Shows the EVM of all DMRS resource elements with 64QAM modulation of the PUSCH in the analyzed frame. `FETCh:SUMMary:EVM:SDSF[:AVERage]?` on page 126
EVM PUCCH	Shows the EVM of all resource elements of the PUCCH channel in the analyzed frame. `FETCh:SUMMary:EVM:UCCH[:AVERage]?` on page 127
EVM DMRS PUCCH	Shows the EVM of all DMRS resource elements of the PUCCH channel in the analyzed frame. `FETCh:SUMMary:EVM:UCCD[:AVERage]?` on page 127
EVM PRACH	Shows the EVM of all resource elements of the PRACH channel in the analyzed frame. `FETCh:SUMMary:EVM:UPRA[:AVERage]?` on page 127

By default, all EVM results are in %. To view the EVM results in dB, change the EVM Unit.

The second part of the table shows results that refer to a specifc selection of the frame.

The statistic is always evaluated over the slots.

The header row of the table contains information about the selection you have made (like the subframe).

EVM All

Shows the EVM for all resource elements in the analyzed frame.

FETCh[:CC<cci>]:SUMMary:EVM[:ALL][:AVERage]? on page 130

EVM Phys Channel

Shows the EVM for all physical channel resource elements in the analyzed frame.

A physical channel corresponds to a set of resource elements carrying information from higher layers. PUSCH, PUCCH and PRACH are physical channels. For more information see 3GPP 36.211.

FETCh[:CC<cci>]:SUMMary:EVM:PCHannel[:AVERage]? on page 130

EVM Phys Signal

Shows the EVM for all physical signal resource elements in the analyzed frame.

The reference signal is a physical signal. For more information see 3GPP 36.211.

FETCh[:CC<cci>]:SUMMary:EVM:PSIGnal[:AVERage]? on page 130

Frequency Error

Shows the difference in the measured center frequency and the reference center frequency.

FETCh[:CC<cci>]:SUMMary:FERRor[:AVERage]? on page 131

Sampling Error

Shows the difference in measured symbol clock and reference symbol clock relative to the system sampling rate.

FETCh[:CC<cci>]:SUMMary:SERRor[:AVERage]? on page 133

I/Q Offset

Shows the power at spectral line 0 normalized to the total transmitted power.

FETCh[:CC<cci>]:SUMMary:IQOFfset[:AVERage]? on page 131

I/Q Gain Imbalance

Shows the logarithm of the gain ratio of the Q-channel to the I-channel.

FETCh[:CC<cci>]:SUMMary:GIMBalance[:AVERage]? on page 131

I/Q Quadrature Error

Shows the measure of the phase angle between Q-channel and I-channel deviating from the ideal 90 degrees.

FETCh[:CC<cci>]:SUMMary:QUADerror[:AVERage]? on page 132

Power

Shows the average time domain power of the allocated resource blocks of the analyzed signal.

FETCh[:CC<cci>]:SUMMary:POWer[:AVERage]? on page 132

Crest Factor

Shows the peak-to-average power ratio of captured signal.

FETCh[:CC<cci>]:SUMMary:CRESt[:AVERage]? on page 129

Marker Table

Displays a table with the current marker values for the active markers.

4 Marker Table

Wnd	Type	Ref	Trc	X-value	Y-value
1	M1		1	13.25 GHz	-200.0 dBm
1	D2	M1	1	-600.0 kHz	0.0 dB
1	D3	M1	1	600.0 kHz	0.0 dB
1	D4	M1	1	-2.0 MHz	0.0 dB

Remote command:

LAY:ADD? '1',RIGH, MTAB, see LAYout:ADD[:WINDow]? on page 103

Results:

CALCulate<n>:MARKer<m>:X on page 136

CALCulate<n>:MARKer<m>:Y? on page 136

2.6 Time Alignment Error Measurements

The Time Alignment Error measurement captures and analyzes new I/Q data when you select it.

Note that the Time Alignment Error measurement only work in a MIMO setup (2 or 4 antennas) or a system with component carriers. Therefore, you have to mix the signal of the antennas into one cable that you can connect to the R&S FSW. For more information on configuring and performing a Time Alignment Error measurement see chapter 3.4, "Performing Time Alignment Measurements", on page 38.

In addition to the result displays mentioned in this section, the Time Alignment Error measurement also supports the following result displays described elsewhere.

- "Capture Buffer" on page 13
- "Power Spectrum" on page 16
- "Marker Table" on page 24

You can select the result displays from the evaluation bar and arrange them as you like with the SmartGrid functionality.

Time Alignment Error
Starts the Time Alignment Error result display.

The time alignment is an indicator of how well the transmission antennas in a MIMO system and component carriers are synchronized. The Time Alignment Error is either the time delay between a reference antenna (for example antenna 1) and another antenna or the time delay between a reference component carrier and other component carriers.

More information.

The application shows the results in a table.

Each row in the table represents one antenna. The reference antenna is not shown.

For each antenna the maximum, minimum and average time delay that has been measured is shown. The minimum and maximum results are calculated only if the measurement covers more than one subframe.

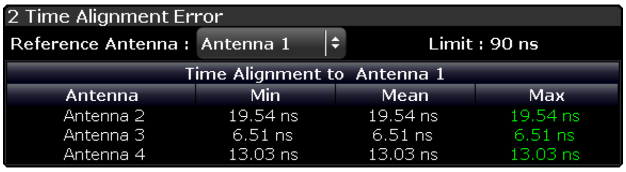
If you perform the measurement on a system with carrier aggregation, each row represents one antenna. The number of lines increases because of multiple carriers. The reference antenna of the main component carrier (CC1) is not shown.

In case of carrier aggregation, the Time Alignment Error measurement also evaluates the "Carrier Frequency Error" on page 26 of the component carrier (CC2) relative to the main component carrier (CC1).

In any case, results are only displayed if the transmission power of both antennas is within 15 dB of each other. Likewise, if only one antenna transmits a signal, results will not be displayed (for example if the cabling on one antenna is faulty).

For more information on configuring this measurement see chapter 4.3, "Configuring Time Alignment Error Measurements", on page 80.

The "Limit" value shown in the result display is the maximum time delay that may occur for each antenna (only displayed for systems without carrier aggregation).



You can select the reference antenna from the dropdown menu in the result display. You can also select the reference antenna in the MIMO Setup - if you change them in one place, they are also changed in the other.

In the default layout, the application also shows the Capture Buffer and Power Spectrum result displays for each component carrier.

Remote command:
Selecting the result displays: LAY:ADD ? '1',LEFT,TAL
Querying results: `FETCh:TAERror[:CC<cci>]:ANTenna<antenna>[:AVERage]?` on page 134

Carrier Frequency Error
Starts the Carrier Frequency Error result display.

The carrier frequency error is an indicator of how well the component carriers in a system with carrier aggregation are synchronized. The Carrier Frequency Error is the frequency deviation between a refrence carrier (usually Component Carrier 1) and another component carrier.

The application shows the results in a table.

For each component carrier, the application adds two rows to the table.

- The first row shows the lowest, average and highest frequency error that has been measured **in Hz**. In addition, the limit defined by 3GPP for that scenario is displayed. Note that the application always tests against the highest measured value; if the limit has been violated, the font color of the maximum value turns red.
  If you perform the measurement over a single slot only, the lowest, average and highest valued are the same.
- The second row shows the lowest, average and highest frequency error that has been measured **in ppm**. In addition, the limit defined by 3GPP for that scenario is displayed.
  If you perform the measurement over a single slot only, the lowest, average and highest valued are the same.

The reference component carrier is not represented in the table.

Remote command:
In Hz: `FETCh:FERRor[:CC<cci>][:AVERage]?` on page 134
In ppm: `FETCh:FEPPm[:CC<cci>][:AVERage]` on page 134

2.7 Frequency Sweep Measurements

The Spectrum Emission Mask (SEM) and Adjacent Channel Leakage Ratio (ACLR) measurements are the only frequency sweep measurements available for the LTE measurement application. They do not use the I/Q data all other measurements use. Instead those measurements sweep the frequency spectrum every time you run a new measurement. Therefore it is not possible to to run an I/Q measurement and then view the results in the frequency sweep measurements and vice-versa. Also because each of the frequency sweep measurements uses different settings to obtain signal data it is not possible to run a frequency sweep measurement and view the results in another frequency sweep measurement.

Frequency sweep measurements are available if RF input is selected.

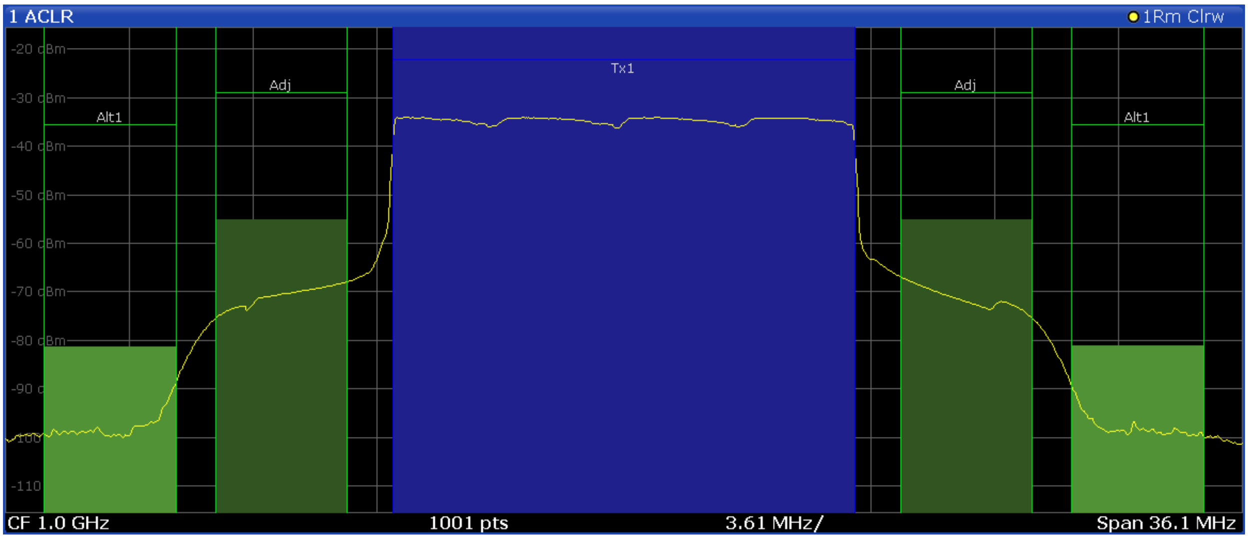
ACLR

Starts the Adjacent Channel Leakage Ratio (ACLR) measurement.

The ACLR measurement analyzes the power of the transmission (TX) channel and the power of the two neighboring channels (adjacent channels) to the left and right of the TX channel. Thus, the ACLR measurement provides information about the power in the adjacent channels as well as the leakage into these adjacent channels.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel and adjacent channel bandwidths. On the y-axis, the power is plotted in dBm.

By default the ACLR settings are based on the selected LTE Channel Bandwidth. You can change the assumed adjacent channel carrier type and, if required, customize the channel setup to your needs. For more information see the documentation of the R&S FSW.



The power for the TX channel is an absolute value in dBm. The power of the adjacent channels are values relative to the power of the TX channel.

In addition, the ACLR measurement results are also tested against the limits defined by 3GPP. In the diagram, the limits are represented by horizontal red lines.

ACLR table

A table above the result display contains information about the measurement in numerical form:

- **Channel**
  Shows the channel type (TX, Adjacent or Alternate Channel).
- **Bandwidth**
  Shows the bandwidth of the channel.
- **Spacing**
  Shows the channel spacing.
- **Lower / Upper**
  Shows the relative power of the lower and upper adjacent and alternate channels
- **Limit**
  Shows the limit of that channel, if one is defined.

2 Result Summary — EUTRA/LTE Square/RRC

Channel	Bandwidth	Offset	Power	
Tx1 (Ref)	13.500 MHz		**-13.56 dBm**	
Tx Total			**-13.56 dBm**	
Channel	**Bandwidth**	**Offset**	**Lower**	**Upper**
Adj	3.840 MHz	10.000 MHz	**-41.48 dB**	**-41.66 dB**
Alt1	3.840 MHz	15.000 MHz	**-67.74 dB**	**-67.62 dB**

Remote command:
Selecting the result display:
CONF:MEAS ACLR
Querying results:
CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?
TRACe:DATA?

Spectrum Mask

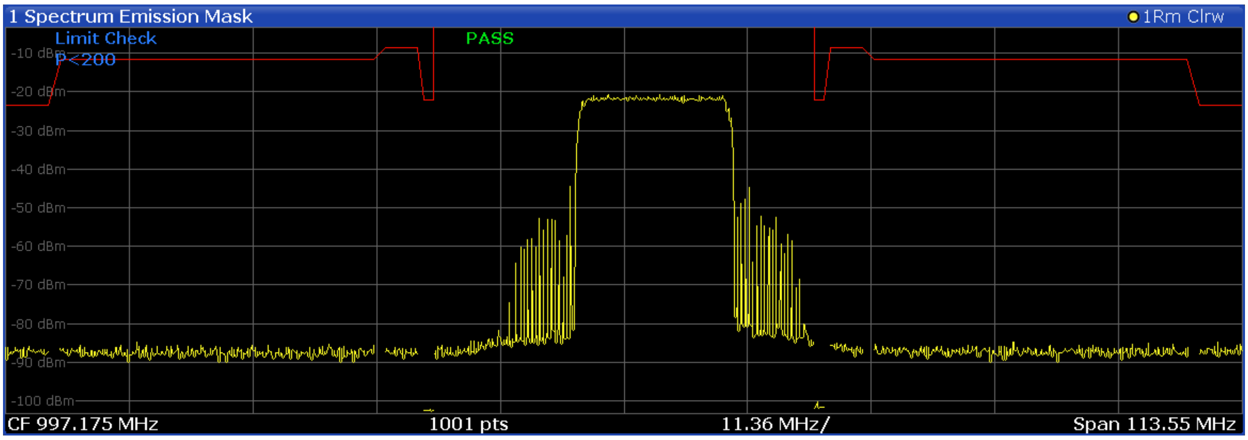
Starts the Spectrum Emission Mask (SEM) result display.

(Note that the SEM measurement also supports carrier aggregation up to two contiguous component carriers. You can configure the component carriers in the Carrier Aggregation panel.)

The Spectrum Emission Mask measurement shows the quality of the measured signal by comparing the power values in the frequency range near the carrier against a spectral mask that is defined by the 3GPP specifications. In this way, you can test the performance of the DUT and identify the emissions and their distance to the limit.

In the diagram, the SEM is represented by a red line. If any measured power levels are above that limit line, the test fails. If all power levels are inside the specified limits, the test is passed. The application labels the limit line to indicate whether the limit check has passed or failed.

The x-axis represents the frequency with a frequency span that relates to the specified EUTRA/LTE channel bandwidths. On the y-axis, the power is plotted in dBm.



A table above the result display contains the numerical values for the limit check at each check point:

- **Start / Stop Freq Rel**
  Shows the start and stop frequency of each section of the Spectrum Mask relative to the center frequency.
- **RBW**
  Shows the resolution bandwidth of each section of the Spectrum Mask
- **Freq at Δ to Limit**
  Shows the absolute frequency whose power measurement being closest to the limit line for the corresponding frequency segment.
- **Power Abs**
  Shows the absolute measured power of the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Power Rel**
  Shows the distance from the measured power to the limit line at the frequency whose power is closest to the limit. The application evaluates this value for each frequency segment.
- **Δ to Limit**
  Shows the minimal distance of the tolerance limit to the SEM trace for the corresponding frequency segment. Negative distances indicate the trace is below the tolerance limit, positive distances indicate the trace is above the tolerance limit.

2 Result Summary
Sub Block A Center 997.18 MHz Tx Power -10.69 dBm RBW 30.000 kHz
Tx Bandwidth 34.850 MHz LTE UL

Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-56.775 MHz	-52.775 MHz	1.000 MHz	942.78889 MHz	-85.96 dBm	-75.26 dB	-62.46 dB
-51.775 MHz	-22.925 MHz	1.000 MHz	972.13506 MHz	-85.54 dBm	-74.85 dB	-74.04 dB
-21.925 MHz	-18.925 MHz	1.000 MHz	977.86111 MHz	-86.04 dBm	-75.35 dB	-77.54 dB
-18.410 MHz	-17.440 MHz	30.000 kHz	979.43187 MHz	-102.33 dBm	-91.64 dB	-80.33 dB
17.440 MHz	18.410 MHz	30.000 kHz	1.01492 GHz	-100.40 dBm	-89.70 dB	-78.40 dB
18.925 MHz	21.925 MHz	1.000 MHz	1.01671 GHz	-85.18 dBm	-74.49 dB	-76.68 dB
22.925 MHz	51.775 MHz	1.000 MHz	1.03284 GHz	-84.80 dBm	-74.11 dB	-73.30 dB
52.775 MHz	56.775 MHz	1.000 MHz	1.05167 GHz	-84.80 dBm	-74.11 dB	-61.30 dB

Remote command:
Selecting the result display: CONF:MEAS ESP
Querying results: TRACe:DATA?

Multi Carrier ACLR
Starts the Multi Carrier Adjacent Channel Leakage Ratio (MC ACLR) measurement.

The MC ACLR measurement is basically the same as the ACLR measurement: it measures the power of the transmission channels and neighboring channels and their effect on each other. Instead of measuring a single carrier, the MC ACLR measures two contiguous component carriers. You can configure the component carriers in the Carrier Aggregation panel. Note that the component carriers have to be next to each other.

In its default state, the MC ACLR measurement measures three neighboring channels above and below the carrier. One of the neighboring channels is assumed to be an EUTRA channel (for example LTE) and the other two are assumed to be UTRA channels (for example WCDMA). Note that you can configure a different neighboring channel setup with the tools provided by the measurement. These tools are the same as those provided in the Spectrum application. For more information, please refer to the documentation of the R&S FSW.

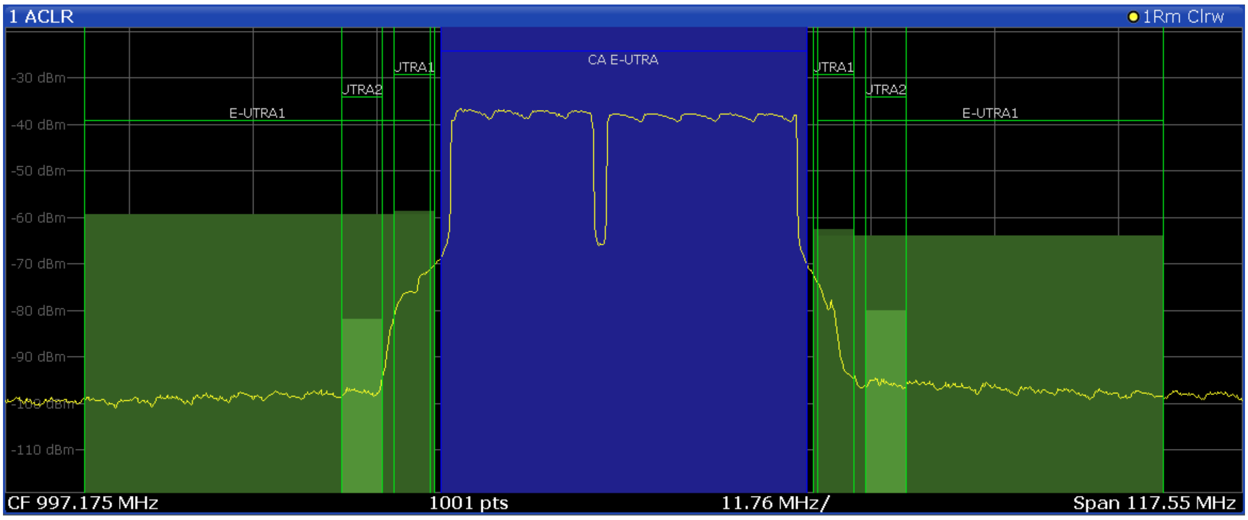
The configuration in its default state complies with the test specifications defined in 3GPP 36.521.

The x-axis represents the frequency with a frequency span that relates to the LTE channel characteristics and adjacent channel bandwidths. Note that the application automatically determines the center frequency of the measurement according to the frequencies of the carriers.

On the y-axis, the power is plotted in dBm. The power for the TX channels is an absolute value in dBm. The power of the adjacent channels are values relative to the power of the TX channel. The power of the channels is automatically tested against the limits defined by 3GPP.

The result display contains several additional elements.

- Blue and green lines:
  Represent the bandwidths of the carriers (blue lines) and those of the neighboring channels (green lines). Note that the channels may overlap each other.
- Blue and green bars:
  Represent the integrated power of the transmission channels (blue bars) and neighboring channels (green bars).



MC ACLR table

A table above the result display contains information about the measurement in numerical form:

- **Channel**
  Shows the type of channel.
  The first two rows represent the aggregated carrier (CA EUTRA Ref and Total: both rows show the characteristics of the aggregated channel and thus are basically the same). Regarding its characteristics, the two carriers are regarded as a single channel.
  The other rows represent the neighboring channels (one E-UTRA and two UTRA channels).
  The other rows represent the neighboring channels (Adj Lower / Upper and Alt1 Lower / Upper).
- **Bandwidth**
  Shows the bandwidth of the channel.
  The bandwidth of the carrier is the sum of the two component carriers.
- **Offset**
  Frequency offset relative to the center frequency of the aggregated carrier.
- **Power / Lower / Upper / Gap**
  Shows the power of the carrier and the power of the lower and upper neighboring channels relative to the power of the aggregated carrier.

2 Result Summary		LTE Carrier Aggregation		
Channel	Bandwidth	Offset	Power	
CA E-UTRA (Ref)	34.850 MHz		-13.19 dBm	
Tx Total			-13.19 dBm	
Channel	Bandwidth	Offset	Lower	Upper
UTRA1	3.840 MHz	19.925 MHz	-45.42 dB	-49.33 dB
UTRA2	3.840 MHz	24.925 MHz	-68.67 dB	-66.96 dB
E-UTRA1	32.850 MHz	34.850 MHz	-46.26 dB	-50.88 dB

Note that the font of the results turns red if the signal violates the limits defined by 3GPP.

Remote command:
Selecting the result display:
CONF:MEAS MCAC
Querying results:
`CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]?`
TRACe:DATA?
Querying limit check results:
`CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult?` on page 137
`CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult?` on page 137

2.8 3GPP Test Scenarios

3GPP defines several test scenarios for measuring user equipment. These test scenarios are described in detail in 3GPP TS 36.521-1.

The following table provides an overview which measurements available in the LTE application are suited to use for the test scenarios in the 3GPP documents.

Table 2-1: Test scenarios for E-TMs as defined by 3GPP (3GPP TS 36.521-1)

Test scenario	Test described in	Measurement
UE Maximum Output Power	chapter 6.2.2	Power (→ Result Summary)
Maximum Power Reduction	chapter 6.2.3	Power (→ Result Summary)
Additional Maximum Power Reduction	chapter 6.2.4	Power (→ Result Summary)
Configured UE-transmitted Output Power	chapter 6.2.5	Power (→ Result Summary)
Minimum Output Power	chapter 6.3.2	Power (→ Result Summary)
Transmit Off Power	chapter 6.3.3	n/a
On/Off Time Mask	chapter 6.3.4	n/a
Power Control	chapter 6.3.5	n/a
Frequency Error	chapter 6.5.1	Frequency Error (→ Result Summary)
Transmit Modulation	chapter 6.5.2.1	EVM results
	chapter 6.5.2.2	I/Q Offset (→ Result Summary)
	chapter 6.5.2.3	Inband Emission
	chapter 6.5.2.4	Spectrum Flatness
Occupied Bandwidth	chapter 6.6.1	Occupied Bandwidth[1]
Out of Band Emission	chapter 6.6.2.1	Spectrum Emission Mask
	chapter 6.6.2.2	Spectrum Emission Mask
	chapter 6.6.2.3	ACLR
Spurious Emissions	chapter 6.6.3.1	Spurious Emissions[1]
	chapter 6.6.3.2	Spurious Emissions[1]
	chapter 6.6.3.3	Spurious Emissions[1]
Transmit Intermodulation	chapter 6.7	ACLR
Time Alignment	chapter 6.8	Time Alignment

[1]these measurements are available in the Spectrum application of the Rohde & Schwarz signal and spectrum analyzers (for example the R&S FSW)

3 Measurement Basics

3.1 Symbols and Variables

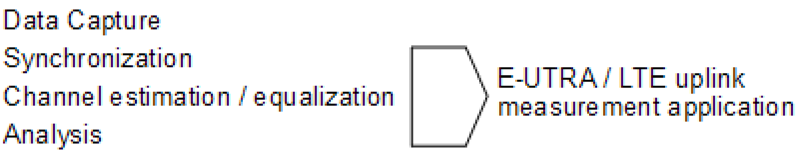
The following chapters use various symbols and variables in the equations that the measurements are based on. The table below explains these symbols for a better understanding of the measurement principles.

$a_{l,k}, \hat{a}_{l,k}$	data symbol (actual, decided)
$A_{l,k}$	data symbol after DFT-precoding
$\Delta f, \Delta \hat{f}_{coarse}$	carrier frequency offset between transmitter and receiver (actual, coarse estimate)
Δf_{res}	residual carrier frequency offset
ζ	relative sampling frequency offset
$H_{l,k}, \hat{H}_{l,k}$	channel transfer function (actual, estimate)
i	time index
$\hat{i}_{coarse}, \hat{i}_{fine}$	timing estimate (coarse, fine)
k	subcarrier index
l	SC-FDMA symbol index
N_{DS}	number of SC-FDMA data symbols
N_{FFT}	length of FFT
N_g	number of samples in cyclic prefix (guard interval)
N_s	number of Nyquist samples
N_{TX}	number of allocated subcarriers
$N_{k,l}$	noise sample
n	index of modulated QAM symbol before DFT pre-coding
Φ_l	common phase error
r_i	received sample in the time domain
$R'_{k,l}$	uncompensated received sample in the frequency domain

$r_{n,l}$	equalized received symbols of measurement path after IDFT
T	duration of the useful part of an SC-FDMA symbol
T_g	duration of the guard interval
T_s	total duration of SC-FDMA symbol

3.2 Overview

The digital signal processing (DSP) involves several stages until the software can present results like the EVM.



The contents of this chapter are structered like the DSP.

3.3 The LTE Uplink Analysis Measurement Application

The block diagram in figure 3-1 shows the general structure of the LTE uplink measurement application from the capture buffer containing the I/Q data up to the actual analysis block.

After synchronization a fully compensated signal is produced in the reference path (purple) which is subsequently passed to the equalizer. An IDFT of the equalized symbols yields observations for the QAM transmit symbols $a_{n,l}$ from which the data estimates $\hat{a}_{n,l}$ are obtained via hard decision. Likewise a user defined compensation as well as equalization is carried out in the measurement path (cyan) and after an IDFT the observations of the QAM transmit symbols are provided. Accordingly, the measurement path might still contain impairments which are compensated in the reference path. The symbols of both signal processing paths form the basis for the analysis.

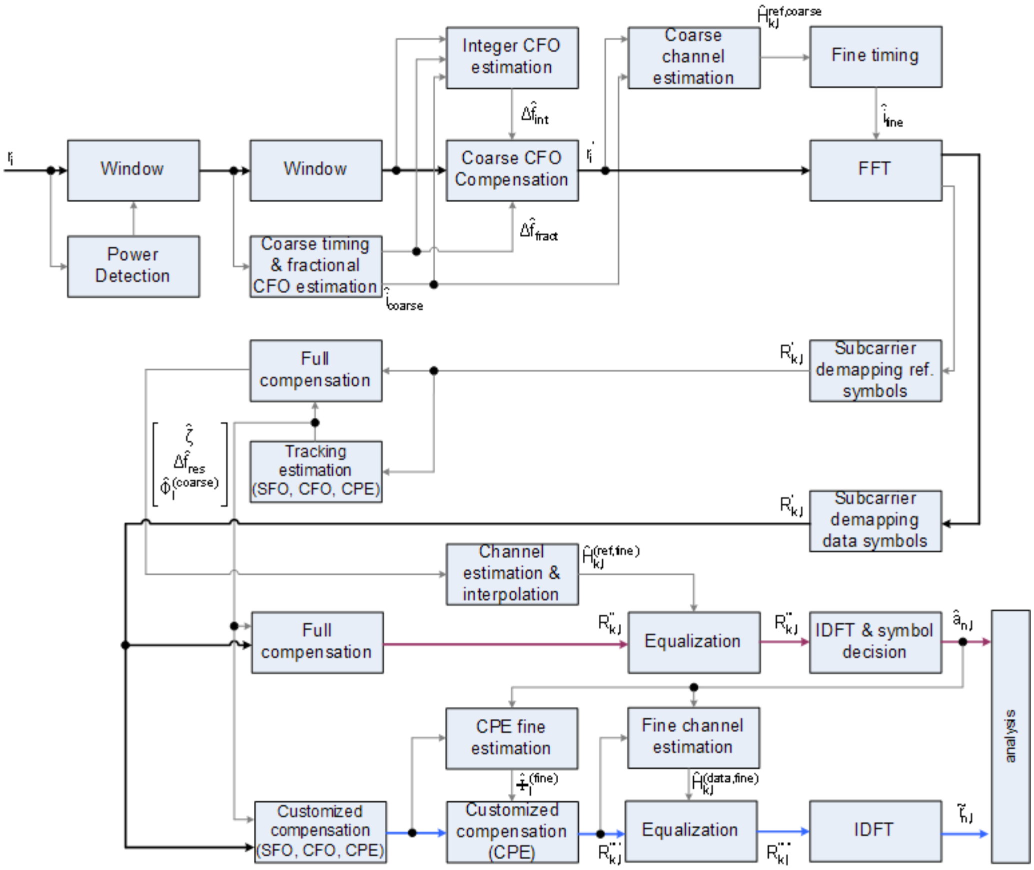


Fig. 3-1: Block diagram for the LTE UL measurement application

3.3.1 Synchronization

In a first step the areas of sufficient power are identified within the captured I/Q data stream which consists of the receive samples r_i. For each area of sufficient power, the analyzer synchronizes on subframes of the uplink generic frame structure [3]. After this coarse timing estimation, the fractional part as well as the integer part of the carrier frequency offset (CFO) are estimated and compensated. In order to obtain an OFDM demodulation via FFT of length N_{FFT} that is not corrupted by ISI, a fine timing is established which refines the coarse timing estimate.

A phase tracking based on the reference SC-FDMA symbols is performed in the frequency domain. The corresponding tracking estimation block provides estimates for

- the relative sampling frequency offset ζ
- the residual carrier frequency offset Δf_{res}
- the common phase error Φ_l

According to references [7] and [8], the uncompensated samples $R'_{k,l}$ in the DFT-precoded domain can be stated as

$$R'_{k,l} = A_{k,l} \cdot H_{k,l} \cdot \underbrace{e^{j\Phi_l}}_{CPE} \cdot \underbrace{e^{j2\pi \cdot N_S/N_{FFT} \cdot \zeta \cdot k \cdot l}}_{SFO} \cdot \underbrace{e^{j2\pi \cdot N_S/N_{FFT} \cdot \Delta f_{res} \cdot T \cdot l}}_{res.CFO} + N_{k,l}$$

(3 - 1)

with

- the DFT precoded data symbol $A_{k,l}$ on subcarrier k at SC-FDMA symbol l,
- the channel transfer function $H_{k,l}$,
- the number of Nyquist samples N_S within the total duration T_S,
- the duration of the useful part of the SC-FDMA symbol $T=T_S-T_g$
- the independent and Gaussian distributed noise sample $N_{k,l}$

Within one SC-FDMA symbol, both the CPE and the residual CFO cause the same phase rotation for each subcarrier, while the rotation due to the SFO depends linearly on the subcarrier index. A linear phase increase in symbol direction can be observed for the residual CFO as well as for the SFO.

The results of the tracking estimation block are used to compensate the samples $R'_{k,l}$ completely in the reference path and according to the user settings in the measurement path. Thus the signal impairments that are of interest to the user are left uncompensated in the measurement path.

After having decoded the data symbols in the reference path, an additional data-aided phase tracking can be utilized to refine the common phase error estimation.

3.3.2 Analysis

The analysis block of the EUTRA/LTE uplink measurement application allows to compute a variety of measurement variables.

EVM

The most important variable is the error vector magnitude which is defined as

$$EVM_{l,k} = \frac{\left|\tilde{r}_{n,l} - \hat{a}_{n,l}\right|}{\sqrt{E\left\{\left|a_{n,l}\right|^2\right\}}}$$

(3 - 2)

for QAM symbol n before precoding and SC-FDMA symbol l. Since the normalized average power of all possible constellations is 1, the equation can be simplified to

$$EVM_{n,l} = \left|\tilde{r}_{n,l} - \hat{a}_{n,l}\right|$$

(3 - 3)

The average EVM of all data subcarriers is then

$$EVM_{data} = \sqrt{\frac{1}{N_{DS}N_{TX}} \sum_{l=0}^{N_{LB}-1} \sum_{n=0}^{N_{TX}-1} EVM_{n,l}^2}$$

(3 - 4)

for N_{DS} SC-FDMA data symbols and the N_{TX} allocated subcarriers.

I/Q imbalance

The I/Q imbalance contained in the continuous received signal r(t) can be written as

$$r(t) = I\,\Re\{s(t)\} + jQ\,\Im\{s(t)\}$$

(3 - 5)

where s(t) is the transmit signal and I and Q are the weighting factors describing the I/Q imbalance. We define that I:=1 and Q:=1+ΔQ.

The I/Q imbalance estimation makes it possible to evaluate the

$$\text{modulator gain balance} = |1 + \Delta Q|$$

(3 - 6)

and the

$$\text{quadrature mismatch} = \arg\{1 + \Delta Q\}$$

(3 - 7)

based on the complex-valued estimate $\Delta\hat{Q}$.

Basic in-band emissions measurement

The in-band emissions are a measure of the interference falling into the non-allocated resources blocks.

The relative in-band emissions are given by

$$Emissions_{relative}(\Delta_{RB}) = \frac{Emissions_{absolute}(\Delta_{RB})}{\frac{1}{|T_S| \cdot N_{RB}} \sum_{t \in T_S} \sum_{c}^{c+12 \cdot N_{RB}-1} |Y(t,f)|^2}$$

(3 - 8)

where T_S is a set $|T_S|$ of SC-FDMA symbols with the considered modulation scheme being active within the measurement period, Δ_{RB} is the starting frequency offset between the allocated RB and the measured non-allocated RB (e.g. Δ_{RB}=1 or Δ_{RB}=-1 for the first adjacent RB), c is the lower edge of the allocated BW, and Y(t,f) is the frequency domain signal evaluated for in-band emissions. N_{RB} is the number of allocated RBs .

The basic in-band emissions measurement interval is defined over one slot in the time domain.

Other measurement variables

Without going into detail, the EUTRA/LTE uplink measurement application additionally provides the following results:

- Total power
- Constellation diagram
- Group delay
- I/Q offset
- Crest factor
- Spectral flatness

3.4 Performing Time Alignment Measurements

The measurement application allows you to perform Time Alignment measurements between different antennas.

You can perform this measurement in 2 Tx antenna MIMO setups.

The result of the measurement is the Time Alignment Error. The Time Alignment Error is the time offset between a reference antenna (for example antenna 1) and another antenna.

The Time Alignment Error results are summarized in the corresponding result display.

A schematic description of the results is provided in figure 3-2.

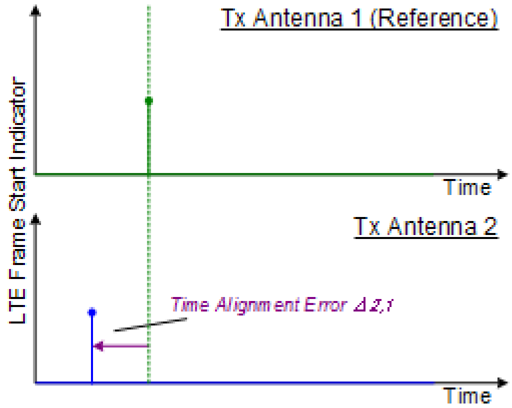


Fig. 3-2: Time Alignment Error (2 Tx antennas)

Test setup

Successful Time Alignment measurements require a correct test setup.

A typical test setup is shown in figure 3-3.

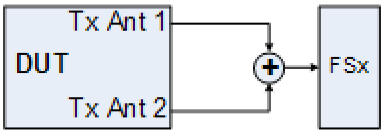


Fig. 3-3: Hardware setup

For best measurement result accuracy it is recommended to use cables of the same length and identical combiners as adders.

In the application, make sure to correctly apply the following settings.

- select a reference antenna in the MIMO Configuration dialog box (**not** "All")
- select more than one antenna in the MIMO Configuration dialog box
- select Codeword-to-Layer mapping "2/1" or "2/2"
- select an Auto Demodulation different to "Subframe Configuration & DMRS"
- the transmit signals of all available Tx antennas have to added together

3.5 SRS EVM Calculation

In order to calculate an accurate EVM, a channel estimation needs to be done prior to the EVM calculation. However, the channel estimation requires a minimum of two resource elements containing reference symbols on a subcarrier. Depending on the current Channel Estimation Range setting, this means that either at least two reference symbols ("Pilot Only") or one reference symbol and at least one data symbol ("Pilot and Payload") need to be available on the subcarrier the EVM is to be measured.

For PUSCH, PUCCH and PRACH regions, these conditions are normally fulfilled because the DMRS (= Demodulation Reference Signal) is already included. However, the SRS may also be located on subcarriers which do not occupy any other reference symbols (see figure 3-4).

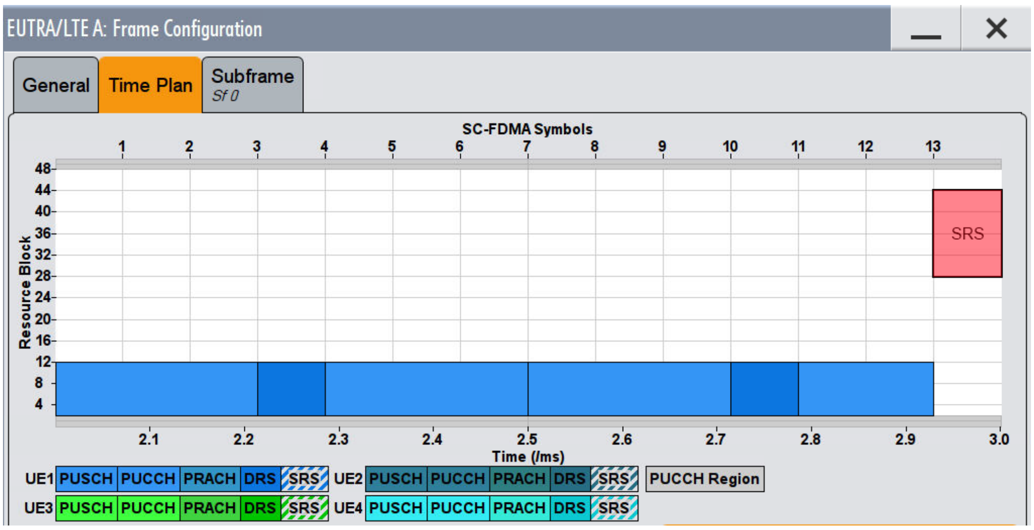


Fig. 3-4: No EVM can be measured for the SRS

In this case it is not reasonable to calculate an EVM and no SRS EVM value will be displayed for the corresponding subframe.

If the SRS subcarriers contain two DMRS symbols (or one DMRS and one PUSCH for "Pilot and Payload" channel estimation range) the SRS EVM can be measured (see figure 3-5).

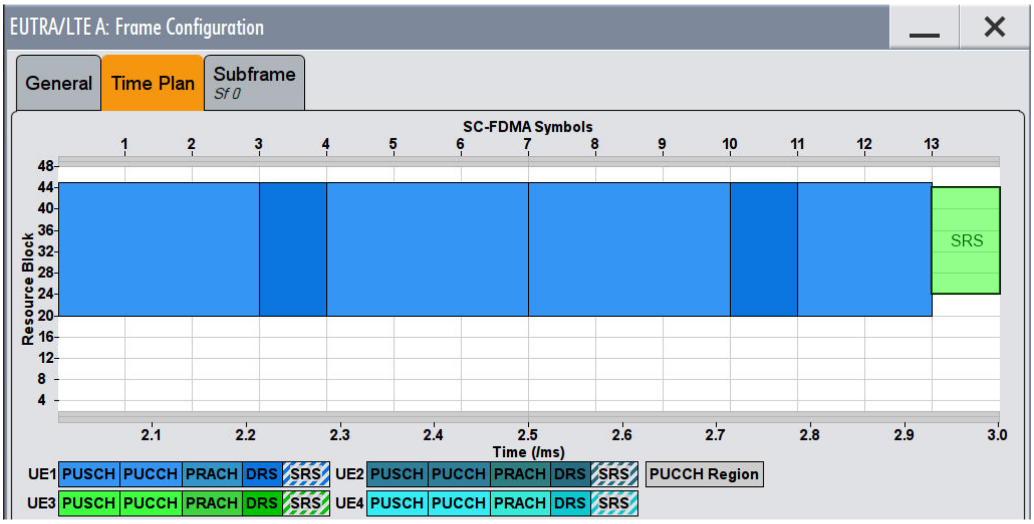


Fig. 3-5: The EVM of the complete SRS can be measured

The SRS allocation might cover subcarriers which partly fulfill the conditions mentioned above and partly do not. In this case the EVM value given in the Allocation Summary will be calculated based only on the subcarriers which fulfill the above requirements (see figure 3-6).

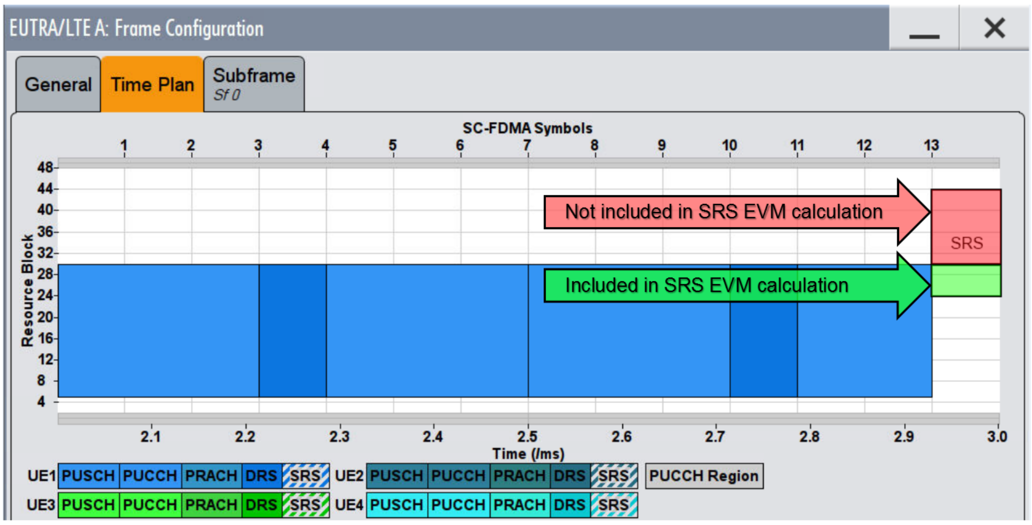


Fig. 3-6: The EVM for parts of the SRS can be measured

4 Configuration

LTE measurements require a special application on the R&S FSW, which you activate using the MODE key on the front panel.

When you start the LTE application, the R&S FSW starts to measure the input signal with the default configuration or the configuration of the last measurement (when you haven't performed a preset since then). After you have started an instance of the LTE application, the application displays the "MEAS CONFIG" menu which contains functions to define the characteristics of the signal you are measuring.

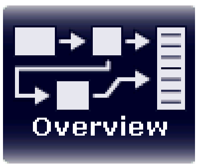
Automatic refresh of preview and visualization in dialog boxes after configuration changes

The R&S FSW supports you in finding the correct measurement settings quickly and easily - after each change in settings in dialog boxes, the preview and visualization areas are updated immediately and automatically to reflect the changes. Thus, you can see if the setting is appropriate or not before accepting the changes.

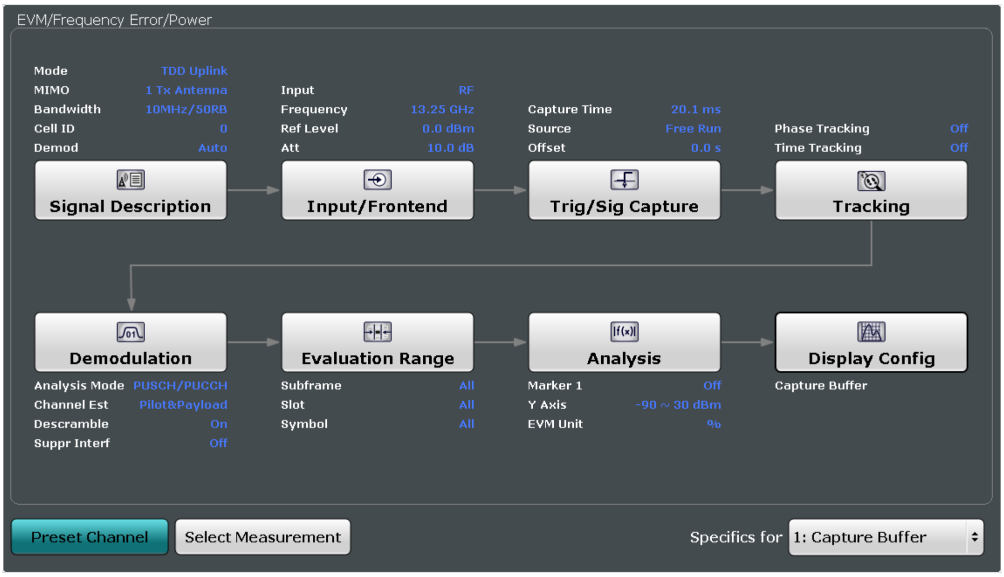
Unavailable hardkeys

Note that the "Trace" and "Limits" menus have no contents and no function in the LTE application.

4.1 Configuration Overview



Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the "Overview". The "Overview" is displayed when you select the "Overview" icon, which is available at the bottom of all softkey menus.



In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. The individual configuration steps are displayed in the order of the data flow. Thus, you can easily configure an entire measurement channel from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview".

In particular, the "Overview" provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. Signal Description
   See chapter 4.2.1, "Defining Signal Characteristics", on page 44.
2. Input / Frontend
   See chapter 4.2.10, "Selecting the Input and Output Source", on page 66.
3. Trigger / Signal Capture
   See chapter 4.2.14, "Triggering Measurements", on page 76
   See chapter 4.2.13, "Configuring the Data Capture", on page 75
4. Tracking
   See chapter 4.2.15, "Tracking", on page 77.
5. Demodulation
   see chapter 4.2.16, "Signal Demodulation", on page 78.
6. Evaluation Range
   See chapter 5.2.1, "Evaluation Range", on page 86.
7. Analysis
   See chapter 5, "Analysis", on page 86.
8. Display Configuration
   See chapter 2, "Measurements and Result Displays", on page 10.

In addition, the dialog box provides the "Select Measurement" button that serves as a shortcut to select the measurement type.

Note that the "Overview" dialog box for frequency sweep measurement is similar to that of the Spectrum mode.

For more information refer to the documentation of the R&S FSW.

To configure settings

► Select any button in the "Overview" to open the corresponding dialog box.
Select a setting in the channel bar (at the top of the measurement channel tab) to change a specific setting.

Preset Channel

Select the "Preset Channel" button in the lower lefthand corner of the "Overview" to restore all measurement settings **in the current channel** to their default values.

Note that the PRESET key restores the entire instrument to its default values and thus closes **all measurement channels** on the R&S FSW (except for the default Spectrum application channel)!

Remote command:
`SYSTem:PRESet:CHANnel[:EXECute]` on page 146

Select Measurement

Opens a dialog box to select the type of measurement.

Using this button has the same effect as pressing the MEAS key.

Using this button has the same effect as selecting the "Select Measurement" menu item in the "Meas Setup" menu.

For more information see chapter 2.1, "Selecting Measurements", on page 10.

Remote command:
`CONFigure[:LTE]:MEASurement` on page 145

Specifics for

The measurement channel may contain several windows for different results. Thus, the settings indicated in the "Overview" and configured in the dialog boxes vary depending on the selected window.

Select an active window from the "Specifics for" selection list that is displayed in the "Overview" and in all window-specific configuration dialog boxes.

The "Overview" and dialog boxes are updated to indicate the settings for the selected window.

4.2 Configuring I/Q Measurements

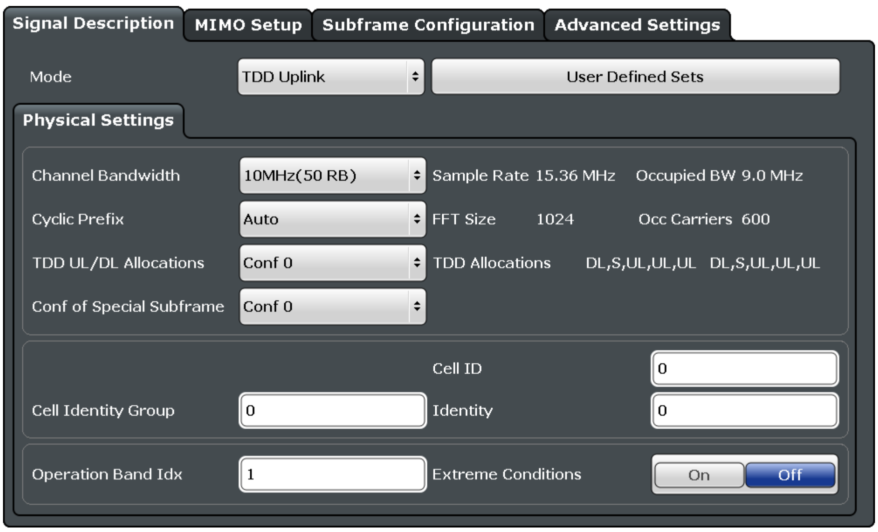
4.2.1 Defining Signal Characteristics

The general signal characteristics contain settings to describe the general physical attributes of the signal. They are part of the "Signal Description" tab of the "Signal Description" dialog box.

To define signal characteristics

Signal characteristics settings can be defined in the "Signal Description" dialog box.

1. Select "Signal Description" from the "Overview" dialog box.
2. Press the MEAS CONFIG key and select the "Signal Description" softkey.



Selecting the LTE Mode

The standard defines the LTE mode you are testing.

The choices you have depend on the set of options you have installed.

- Option xxx-K100 enables testing of 3GPP LTE FDD signals on the downlink
- Option xxx-K101 enables testing of 3GPP LTE FDD signals on the uplink
- Option xxx-K102 enables testing of 3GPP LTE MIMO signals on the downlink
- Option xxx-K103 enables testing of 3GPP MIMO signals on the uplink
- Option xxx-K104 enables testing of 3GPP LTE TDD signals on the downlink
- Option xxx-K105 enables testing of 3GPP LTE TDD signals on the uplink

FDD and TDD are **duplexing** methods.

- FDD mode uses different frequencies for the uplink and the downlink.
- TDD mode uses the same frequency for the uplink and the downlink.

Downlink (DL) and Uplink (UL) describe the **transmission path**.

- Downlink is the transmission path from the base station to the user equipment. The physical layer mode for the downlink is always OFDMA.
- Uplink is the transmission path from the user equipment to the base station. The physical layer mode for the uplink is always SC-FDMA.

The application shows the currently selected LTE mode (including the bandwidth) in the channel bar.

Remote command:
Link direction: `CONFigure[:LTE]:LDIRection` on page 148
Duplexing mode: `CONFigure[:LTE]:DUPLexing` on page 147

Using Test Models

Test models are descriptions of LTE signals that you can use for particular test scenar-ios.

The "Test Models" dialog box contains functionality to select, manage and create test models.

- "Specification"
  The "Specification" tab contains predefined test models as defined by 3GPP.
  Predefined test models are supported in downlink mode.
- "User Defined"
  The "User Defined" tab contains functionality to manage custom test models.
  Custom test models are supported in downlink and uplink mode.
  To create a custom test model, describe a signal as required and then save it via the "Test Models" dialog box.
  Here, you can also restore custom test models and delete ones you do not need anymore.

Predefined test models (E-TM)

In case of downlink signals, the 3GPP standard (TS 36.141) already defines several EUTRA test models (E-TM) for specific test scenarios. These test models are split into three main groups (E-TM1, E-TM2 and E-TM3) and are defined by the following characteristics.

- single antenna port, single code word, single layer and no precoding
- duration of one frame
- normal cyclic prefix
- localized virtual resource blocks, no intra-subframe hopping for PDSCH
- UE-specific reference signal not used

The data content of the physical channels and signals are defined in the 3GPP standard. Each E-TM is defined for for all bandwidths defined in the standard (1.4 MHz / 3 MHz / 5 MHz / 10 MHz / 15 MHz / 20 MHz).

Channel Bandwidth / Number of Resource Blocks

Specifies the channel bandwidth and number of resource blocks (RB).

The channel bandwidth and number of resource blocks (RB) are interdependent. Currently, the LTE standard recommends six bandwidths (see table below).

The application also calculates the FFT size, sampling rate, occupied bandwidth and occupied carriers from the channel bandwidth. Those are read only.

Channel Bandwidth [MHz]	1.4	3	5	10	15	20
Number of Resource Blocks	6	15	25	50	75	100
Sample Rate [MHz]	1.92	3.84	7.68	15.36	30.72	30.72
FFT Size	128	256	512	1024	2048	2048

For more information about configuring aggregated carriers (for example for MC ACLR measurements) see "Carrier Aggregation" on page 81.

The application shows the currently selected LTE mode (including the bandwidth) in the channel bar.

Remote command:
`CONFigure[:LTE]:UL[:CC<cci>]:BW` on page 148

Cyclic Prefix

The cyclic prefix serves as a guard interval between OFDM symbols to avoid interferences. The standard specifies two cyclic prefix modes with a different length each.

The cyclic prefix mode defines the number of OFDM symbols in a slot.

- Normal
  A slot contains 7 OFDM symbols.
- Extended
  A slot contains 6 OFDM symbols.

The extended cyclic prefix is able to cover larger cell sizes with higher delay spread of the radio channel.

- Auto
  The application automatically detects the cyclic prefix mode in use.

Remote command:
CONFigure[:LTE]:UL[:CC<cci>]:CYCPrefix on page 148

Configuring TDD Frames

TDD frames contain both uplink and downlink information separated in time with every subframe being responsible for either uplink or downlink transmission. The standard specifies several subframe configurations or resource allocations for TDD systems.

TDD UL/DL Allocations ← Configuring TDD Frames

Selects the configuration of the subframes in a radio frame in TDD systems.

The UL/DL configuration (or allocation) defines the way each subframe is used: for uplink, downlink or if it is a special subframe. The standard specifies seven different configurations.

Configuration	Subframe Number and Usage									
	0	1	2	3	4	5	6	7	8	9
0	D	S	U	U	U	D	S	U	U	U
1	D	S	U	U	D	D	S	U	U	D
2	D	S	U	D	D	D	S	U	D	D
3	D	S	U	U	U	D	D	D	D	D
4	D	S	U	U	D	D	D	D	D	D
5	D	S	U	D	D	D	D	D	D	D
6	D	S	U	U	U	D	S	U	U	D

U = uplink
D = downlink
S = special subframe

Remote command:
Subframe: CONFigure[:LTE]:UL[:CC<cci>]:TDD:UDConf on page 150

Conf. of Special Subframe ← Configuring TDD Frames

In combination with the cyclic prefix, the special subframes serve as guard periods for switches from uplink to downlink. They contain three parts or fields.

- DwPTS
  The DwPTS is the downlink part of the special subframe. It is used to transmit downlink data.
- GP
  The guard period makes sure that there are no overlaps of up- and downlink signals during a switch.
- UpPTS
  The UpPTS is the uplink part of the special subframe. It is used to transmit uplink data.

The length of the three fields is variable. This results in several possible configurations of the special subframe. The LTE standard defines 10 different configurations for the special subframe. However, configurations 8 and 9 only work for a normal cyclic prefix.

If you select configurations 8 or 9 using an extended cyclic prefix or automatic detection of the cyclic prefix, the application will show an error message.

Remote command:
Special subframe: CONFigure[:LTE]:UL[:CC<cci>]:TDD:SPSC on page 149

Configuring the Physical Layer Cell Identity

The cell ID, cell identity group and physical layer identity are interdependent parameters. In combination they are responsible for synchronization between network and user equipment.

The physical layer cell ID identifies a particular radio cell in the LTE network. The cell identities are divided into 168 unique cell identity groups. Each group consists of 3 physical layer identities. According to

$$N_{ID}^{cell} = 3 \cdot N_{ID}^{(1)} + N_{ID}^{(2)}$$

$N^{(1)}$ = cell identity group, {0...167}
$N^{(2)}$ = physical layer identity, {0...2}

there is a total of 504 different cell IDs.

If you change one of these three parameters, the application automatically updates the other two.

The Cell ID determines

- the reference signal grouping hopping pattern
- the reference signal sequence hopping
- the PUSCH demodulation reference signal pseudo-random sequence
- the cyclic shifts for PUCCH formats 1/1a/1b and sequences for PUCCH formats 2/2a/2b
- the pseudo-random sequence used for scrambling
- the pseudo-random sequence used for type 2 PUSCH frequency hopping

Remote command:
Cell ID: CONFigure[:LTE]:UL[:CC<cci>]:PLC:CID on page 149
Cell Identity Group: CONFigure[:LTE]:UL[:CC<cci>]:PLC:CIDGroup on page 149
Identity: CONFigure[:LTE]:UL[:CC<cci>]:PLC:PLID on page 149

Operating Band Index

Selects one of the 40 operating bands for spectrum flatness measurements as defined in TS 36.101.

The operating band defines the frequency band and the dedicated duplex mode.

Remote command:
[SENSe][:LTE]:SFLatness:OBANd on page 151

Extreme Conditions

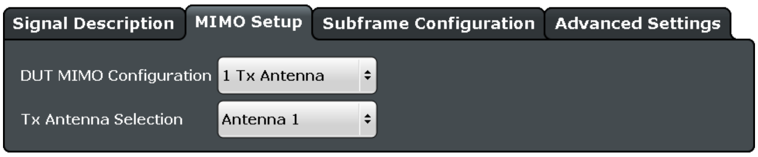
Turns extreme conditions on and off.

If you turn the extreme conditions on, the software will modify the limit lines for the limit check of the spectral flatness measurement.

Remote command:
[SENSe][:LTE]:SFLatness:ECONditions on page 151

4.2.2 Configuring MIMO Setups

The MIMO Configuration contains settings to configure MIMO test setups.



MIMO Configuration

Selects the antenna configuration and test conditions for a MIMO system.

The MIMO **configuration** selects the number of transmit antennas for selected channels in the system.

In setups with multiple antennas, the **antenna selection** defines the antenna you'd like to test. Note that as soon as you have selected a transmission on more than one antenna for one of the channels, the corresponding number of antennas becomes available for testing.

Antenna 1	Tests antenna 1 only.
Antenna 2	Tests antenna 2 only.
Antenna 3	Tests antenna 3 only.
Antenna 4	Tests antenna 4 only.

Remote command:
`CONFigure[:LTE]:UL:MIMO:ASELection` on page 152

4.2.3 Configuring Subframes

An LTE frame consists of 10 subframes. Each individual subframe may have a different resource block configuration. This configuration is shown in the "Subframe Configuration Table".

The application supports two ways to determine the characteristics of each subframe.

- Automatic demodulation of the channel configuration and detection of the subframe characteristics.
  In case of automatic demodulation, the contents of the table are determined according to the signal currently evaluated.
  For more information see "Auto Demodulation" on page 50.
- Custom configuration of the configuration of each subframe.
  In case of manual configuration, you can customize the table according to the signal that you expect. The signal is demodulated even if the signal does not fit the decription in the table or, in case of Physical Detection, only if the frame fits the description in the table.
  Remote command:
  Conf. subframes: `CONFigure[:LTE]:UL:CSUBframes` on page 152

Frame number offset

A frame number offset is also supported. The frame number offset assigns a number to the demodulated frame in order to identify it in a series of transmitted (and captured) frames. You can define this frame in the Global Settings.

Remote command:

`CONFigure[:LTE]:UL:SFNO` on page 157

4.2.3.1 General Subframe Configuration

Auto Demodulation

Turns automatic demodulation on and off.

If active, the R&S FSW automatically detects the characteristics of each subframe in the signal (resource allocation of the signal).

Two methods of detection are supported:

- Auto Demodulation, **DMRS Auto Detection (Off)**
  This method automatically determines the characteristics for each subframe as shown in the Subframe Configuration Table.
  The table is populated accordingly.
- Subframe Configuration & DMRS
  Auto Demodulation, **DMRS Auto Detection (On)**
  This method automatically detects the PUSCH and SRS (i.e. no PUCCH can be detected).
  To determine these characteristics, the software detects the CAZAC base parameters. Thus, the DMRS configuration parameters are not required for the synchronization and therefore are not available using this method.
  Note however that it is not possible to derive the DMRS configuration parameters from the CAZAC base parameters so that the disabled DMRS configuration parameters do not reflect the current parameters used for the synchronization. Also note that it can happen that the software successfully synchronizes on non-3GPP signals without a warning.

Automatic demodulation is not available if the Suppressed Interference Synchronization is active.

Remote command:

`[SENSe][:LTE]:UL:DEMod:ACON` on page 156

Subframe Configuration Detection

Turns the detection of the subframe configuration on and off.

Upon activation, the software compares the current demodulated LTE frame to the subframe configuration you have set. Only if the signal is consistent with the configuration, the software will further analyze the LTE frame.

If inactive, the software analyzes the signal even if it is not consistent with the current subframe configuration.

Subframe configuration detection is available if you are using a Predefined subframe configuration.

Remote command:
`[SENSe][:LTE]:UL:FORMat:SCD` on page 156

4.2.3.2 Individual Subframe Configuration

The "Subframe Configuration Table" contains the characteristics for each subframe. The software supports a maximum uplink LTE frame size of 10 subframes. The sub-frame number in the table depends on the number of "Configurable Subframes" that you have defined or that have been detected in case of automatic demodulation.

Subframe	Enable PUCCH	Enable PUSCH	Modulation	Enhanced Settings	Number of RBs	Offset RB	Conflict
0 (Not Us...							
1 (Not Us...							
2	Off	On	QPSK	...	10	2	
3	Off	On	QPSK	...	10	2	
4	Off	On	QPSK	...	10	2	
5 (Not Us...							
6 (Not Us...							

Each row of the table represents one subframe. If the fields in a row are unavailable for editing, the corresponding subframe is occupied by a downlink subframe or the special subframe (in TDD systems).

Subframe Number
Shows the number of a subframe.

Note that, depending on the TDD configuration, some subframes may not be available for editing. The R&S FSW labels those subframes "(not used)".

Enable PUCCH
Turns the PUCCH in the corresponding subframe on and off.

Remote command:
`CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:CONT`
on page 152

Enable PUSCH
Turns the PUSCH in the corresponding subframe on and off.

If you turn on a PUSCH, "Modulation", "Number of RBs" and "Offset RB" become available.

Remote command:
`CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:CONT` on page 152

Modulation
Selects the modulation scheme for the corresponding PUSCH allocation.

The modulation scheme is either QPSK, 16QAM or 64QAM.

Remote command:
`CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:MODulation` on page 153

Enhanced Settings
Opens a dialog box to configure enhanced functionality for selected channels in each subframe.

For more information see Enhanced Settings.

Number of RB
Sets the number of resource blocks the PUSCH allocation covers. The number of resource blocks defines the size or bandwidth of the PUSCH allocation.

Remote command:
`CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc[:CLUSter<cluster>]:RBCount` on page 155

Offset RB
Sets the resource block at which the PUSCH allocation begins.

Make sure not to allocate PUSCH allocations into regions reserved for PUCCH allocations.

Remote command:
`CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc[:CLUSter<cluster>]:RBOFfset` on page 156

4.2.3.3 Enhanced Settings

The "Enhanced Settings" contain functionality to define enhanced characteristics for selected channels.

Enhanced PUSCH Configuration
Configures the PUSCH in individual subframes.

Resource Allocation Type 1

Turns a clustered PUSCH allocation an and off. If on, a second row is added to the corresponding allocation. This second row represents the second cluster.

You can define the number of resource block and the offset resource block for each cluster. All other parameters (power, modulation etc.) are the same for both clusters.

Precoding Settings

If you are using a clustered PUSCH, you can also define the number of layers for any allocation and the codebook index.

The number of layers of an allocation in combination with the number of code words determines the layer mapping. The available number of layers depends on the number of transmission antennas. Thus, the maximum number of layers you can select is four.

The codebook index determines the precoding matrix. The available number of indices depends on the number of transmission antennas in use. The range is from 0 to 23.

Remote command:
CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:RATO on page 155
CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:PRECoding:CLMapping on page 153
CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:PRECoding:CBINdex on page 153

Enhanced Demodulation Reference Signal Configuration

Configures the Demodulation Reference Signal in individual subframes.

n(2)_DMRS

Defines the part of the demodulation reference signal index that is part of the uplink scheduling assignment. Thus, this part of the index is valid for corresponding UE and subframe only.

The index applies when multiple shifts within a cell are used. It is used for the calculation of the DMRS sequence.

Cyclic Shift Field

If Activate-DMRS-With OCC is on, the "Cyclic Shift Field" becomes available to define the cyclic shift field.

The Cyclic Shift Field is signalled by the PDCCH downlink channel in DCI format 0 and 4. It selects n(2)_DMRS and the orthogonal sequence (OCC) for signals according to LTE release 10.

If the "Cyclic Shift Field" is off, the demodulation reference signal is configured by the n(2)_DMRS parameter.

Remote command:
CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:PUSCh:NDMRs on page 155
CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:PUSCh:CSField on page 154

Enhanced PUCCH Configuration

Configures the PUSCH in individual subframes.

n_PUCCH

Defines the n_PUCCH parameter for the selected subframe.

Available only if you have selected "Per Subframe" for the N_PUCCH.

PUCCH Format

Selects the PUCCH format for the selected subframe.

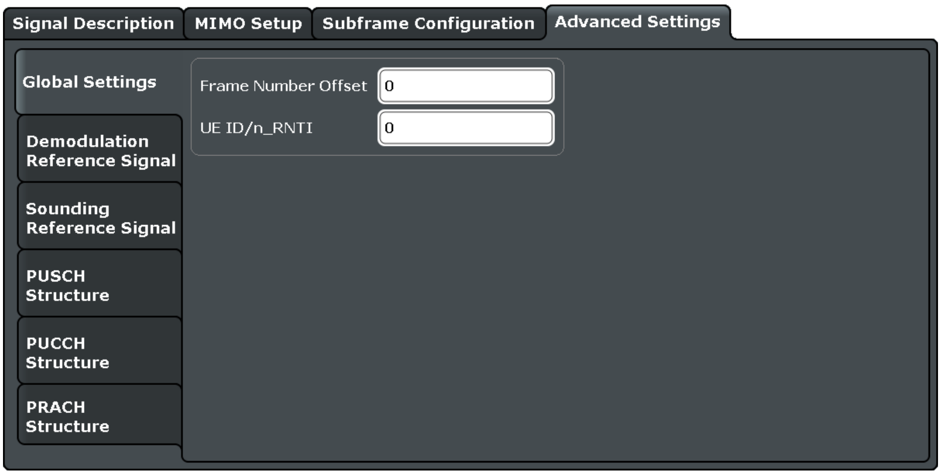
Available only if you have selected "Per Subframe" for the Format.

Remote command:
n_PUCCH: CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:PUCCh:NPAR on page 154
Format: CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:PUCCh:FORMat on page 154

4.2.4 Defining Global Signal Characteristics

The global settings contain settings that apply to the complete signal.

The global signal settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



Frame Number Offset

Defines a frame number offset for the analyzed frame.

The frame number offset assigns a number to the demodulated frame in order to identify it in a series of transmitted (and captured) frames.

Remote command:

`CONFigure[:LTE]:UL:SFNO` on page 157

UE ID/n_RNTI

Sets the radio network temporary identifier (RNTI) of the UE.

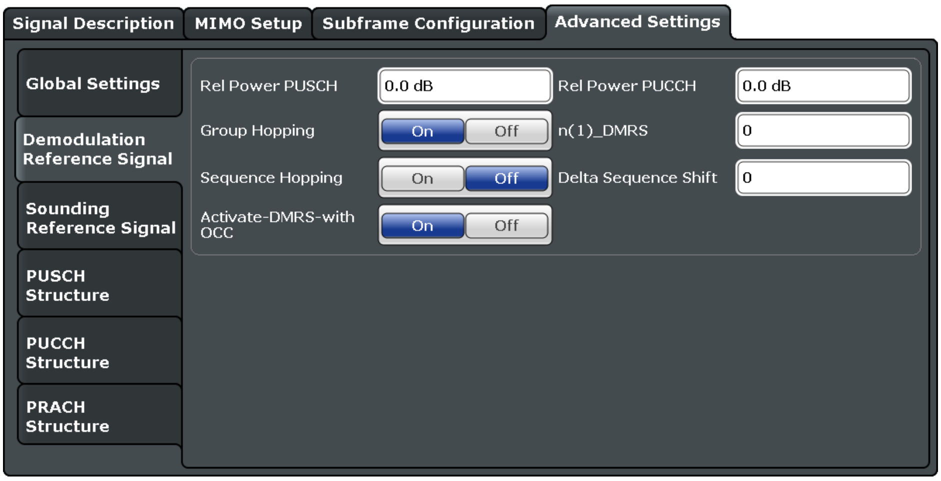
Remote command:

`CONFigure[:LTE]:UL:UEID` on page 157

4.2.5 Configuring the Demodulation Reference Signal

The demodulation reference signal (DRS) settings contain settings that define the physical attributes and structure of the demodulation reference signal. This reference signal helps to demodulate the PUSCH.

The demodulation reference signal settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



Relative Power PUSCH

Defines the power of the DMRS relative to the power level of the PUSCH allocation in the corresponding subframe (P_{DMRS_Offset}).

The effective power level of the DMRS depends on the allocation of the subframe and is calculated as follows.

$P_{DMRS} = P_{UE} + P_{PUSCH} + P_{DMRS\_Offset}$

The relative power of the DMRS is applied to all subframes.

The power of the PUSCH (P_{PUSCH}) may be different in each subframe.

Remote command:

`CONFigure[:LTE]:UL[:CC<cci>]:DRS[:PUSCh]:POWer` on page 159

Group Hopping

Turns group hopping for the demodulation reference signal on and off.

The group hopping pattern is based on 17 hopping patterns and 30 sequence shift patterns. It is generated by a pseudo-random sequence generator.

If on, PUSCH and PUCCH use the same group hopping pattern.

Remote command:

`CONFigure[:LTE]:UL[:CC<cci>]:DRS:GRPHopping` on page 158

Sequence Hopping

Turns sequence hopping for the uplink demodulation reference signal on and off.

Sequence hopping is generated by a pseudo-random sequence generator.

Remote command:

`CONFigure[:LTE]:UL[:CC<cci>]:DRS:SEQHopping` on page 159

Relative Power PUCCH
Defines the power of the DMRS relative to the power level of the PUCCH allocation in the corresponding subframe (P_{DMRS_Offset}).

The effective power level of the DMRS depends on the allocation of the subframe and is calculated as follows.

$P_{DMRS} = P_{UE} + P_{PUCCH} + P_{DMRS\_Offset}$

The relative power of the DMRS is applied to all subframes.

The power of the PUCCH (P_{PUCCH}) may be different in each subframe.

Remote command:
`CONFigure[:LTE]:UL[:CC<cci>]:DRS:PUCCh:POWer` on page 158

n(1)_DMRS
Defines the part of the demodulation reference signal index that is broadcast. It is valid for the whole cell.

The index applies when multiple shifts within a cell are used. It is used for the calculation of the DMRS sequence.

The n_DMRS parameter can be found in 3GPP TS36.211 V8.5.0, 5.5.2.1.1 Reference signal sequence.

Remote command:
`CONFigure[:LTE]:UL[:CC<cci>]:DRS:NDMRs` on page 158

Delta Sequence Shift
Defines the delta sequence shift Δ_{SS}.

The standard defines a sequence shift pattern f_{ss} for the PUCCH. The corresponding sequence shift pattern for the PUSCH is a function of f_{ss}^{PUCCH} and the delta sequence shift.

For more information refer to 3GPP TS 36.211, chapter 5.5.1.3 "Group Hopping".

Remote command:
`CONFigure[:LTE]:UL[:CC<cci>]:DRS:DSSHift` on page 158

Activate-DMRS-With OCC
Turns the configuration of the demodulation reference signal on a subframe basis via the "Cyclic Shift Field" on and off.

If on, the "Cyclic Shift Field" becomes available. Otherwise, the demodulation reference signal is configured by the n(2)_DMRS parameter.

Note that this parameter is automatically turned on if at least one of the physical channels uses more than one antenna.

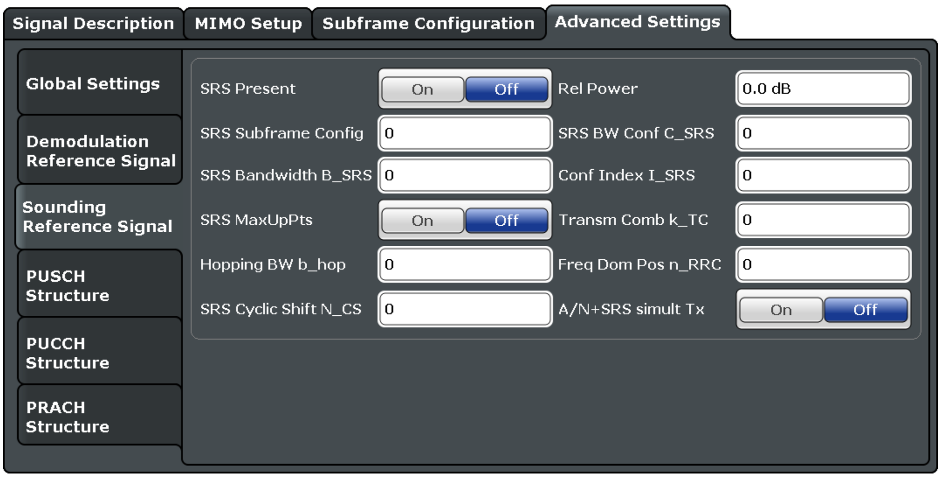
For more information see Enhanced Settings and MIMO Configuration.

Remote command:
`CONFigure[:LTE]:UL[:CC<cci>]:DRS:AOCC` on page 157

4.2.6 Configuring the Sounding Reference Signal

The sounding reference signal (SRS) settings contain settings that define the physical attributes and structure of the sounding reference signal.

The sounding reference signal settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



Present

Includes or excludes the sounding reference signal (SRS) from the test setup.

Remote command:

`CONFigure[:LTE]:UL:SRS:STAT` on page 162

SRS Subframe Conf.

Defines the subframe configuration of the SRS.

The subframe configuration of the SRS is specific to a cell. The UE sends a shortened PUCCH/PUSCH in these subframes, regardless of whether the UE is configured to send an SRS in the corresponding subframe or not.

Remote command:

`CONFigure[:LTE]:UL:SRS:SUConfig` on page 162

SRS MaxUpPts

Turns the parameter srs_MaxUpPts on and off.

srs_MaxUpPts controls the SRS transmission in the UpPTS field in TDD systems. If on, the SRS is transmitted in a frequency range of the UpPTS field that does not overlap with resources reserved for PRACH preamble 4 transmissions.

To avoid an overlap, the number of SRS resource blocks otherwise determined by C_SRS and B_SRS is reconfigured.

Remote command:
`CONFigure[:LTE]:UL:SRS:MUPT` on page 161

SRS Bandwidth B_SRS

Defines the parameter B_{SRS}.

B_{SRS} is a UE specific parameter that defines the bandwidth of the SRS. The SRS either spans the entire frequency bandwidth or uses frequency hopping when several narrowband SRS cover the same total bandwidth.

The standard defines up to four bandwidths for the SRS. The most narrow SRS bandwidth (B_{SRS} = 3) spans four resource blocks and is available for all channel bandwidths. The other three values of B_{SRS} define more wideband SRS bandwidths. Their availability depends on the channel bandwidth.

The availability of SRS bandwidths additionally depends on the bandwidth configuration of the SRS (C_{SRS}).

For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
`CONFigure[:LTE]:UL:SRS:BSRS` on page 160

Hopping BW b_hop

Defines the parameter b_{hop}.

b_{hop} is a UE specific parameter that defines the frequency hopping bandwidth. SRS frequency hopping is active if $b_{hop} < B_{SRS}$.

For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
`CONFigure[:LTE]:UL:SRS:BHOP` on page 160

SRS Cyclic Shift N_CS

Defines the cyclic shift (n_{CS}) used for the generation of the SRS CAZAC sequence.

Because the different shifts of the same Zadoff-Chu sequence are orthogonal to each other, applying different SRS cyclic shifts can be used to schedule different UE to simultaneously transmit their SRS.

Remote command:
`CONFigure[:LTE]:UL:SRS:CYCS` on page 161

SRS Rel Power

Defines the power of the SRS relative to the power of the corresponding UE (P_{SRS_Offset}).

The effective power level of the SRS is calculated as follows.

$P_{SRS} = P_{UE} + P_{SRS\_Offset}$

The relative power of the SRS is applied to all subframes.

Remote command:
`CONFigure[:LTE]:UL:SRS:POWer` on page 162

SRS BW Conf. C_SRS

Defines the bandwidth configuration of the SRS.

The bandwidth configuration is a cell specific parameter that, in combination with the SRS bandwidth and the channel bandwidth, defines the length of the souunding reference signal sequence. For more information on the calculation refer to 3GPP TS 36.211 chapter 5.5.3 "Sounding Reference Signal".

Remote command:
`CONFigure[:LTE]:UL:SRS:CSRS` on page 160

Conf. Index I_SRS

Defines the configuration index of the SRS.

The configuration index I_{SRS} is a cell specific parameter that determines the SRS periodicity (T_{SRS}) and the SRS subframe offset (T_{offset}). The effects of the configuration index on T_{SRS} and T_{offset} depends on the duplexing mode.

For more information refer to 3GPP TS 36.213, Table 8.2-1 (FDD) and 8.2-2 (TDD).

Remote command:
`CONFigure[:LTE]:UL:SRS:ISRS` on page 161

Transm. Comb. k_TC

Defines the transmission comb k_{TC}.

The transmission comb. is a UE specific parameter. For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
`CONFigure[:LTE]:UL:SRS:TRComb` on page 162

Freq. Domain Pos. n_RRC

Defines the parameter n_{RRC}.

n_{RRC} is a UE specific parameter and determines the starting physical resource block of the SRS transmission.

For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
`CONFigure[:LTE]:UL:SRS:NRRC` on page 161

A/N + SRS Simultaneous TX
Turns simultaneous transmission of the Sounding Reference Signal (SRS) and ACK/NACK messages (via PUCCH) on and off.

By turning the parameter on, you allow for simultaneous transmission of PUCCH and SRS in the same subframe.

If off, the SRS not transmitted in the subframe for which you have configured simultaneous transmission of PUCCH and SRS.

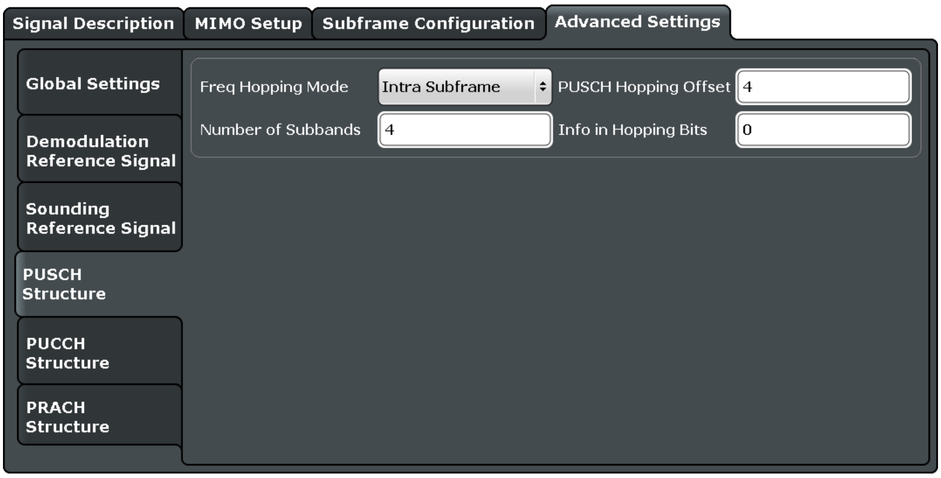
Note that simultaneous transmission of SRS and PUCCH is available only if the PUCCH format is either 1, 1a, 1b or 3. The other PUCCH formats contain CQI reports which are not transmitted with the SRS.

Remote command:
`CONFigure[:LTE]:UL:SRS:ANST` on page 159

4.2.7 Defining the PUSCH Structure

The PUSCH structure settings contain settings that describe the physical attributes and structure of the PUSCH.

The PUSCH structure settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



Frequency Hopping Mode
Selects the frequency hopping mode of the PUSCH.

Several hopping modes are supported.

- None
  No frequency hopping.
- Inter Subframe Hopping
  PUSCH changes the frequency from one subframe to another.
- Intra Subframe Hopping

PUSCH also changes the frequency within a subframe.

Remote command:
`CONFigure[:LTE]:UL[:CC<cci>]:PUSCh:FHMode` on page 163

Number of Subbands

Defines the number of subbands reserved for PUSCH.

For more information refer to 3GPP TS 36.211, chapter 5.5.3.2 "Mapping to Physical Resources" for the Sounding Reference Signal.

Remote command:
`CONFigure[:LTE]:UL[:CC<cci>]:PUSCh:NOSM` on page 164

PUSCH Hopping Offset

Defines the PUSCH Hopping Offset N_{RB}^{HO}.

The PUSCH Hopping Offset determines the first physical resource block and the maximum number of physical resource blocks available for PUSCH transmission if PUSCH frequency hopping is active.

Remote command:
`CONFigure[:LTE]:UL[:CC<cci>]:PUSCh:FHOFfset` on page 163

Info. in Hopping Bits

Defines the information available in the hopping bits according to the PDCCH DCI format 0 hopping bit definition.

The information in the hopping bits determines whether type 1 or type 2 hopping is used in the subframe and, in case of type 1, additionally determines the exact hopping function to use.

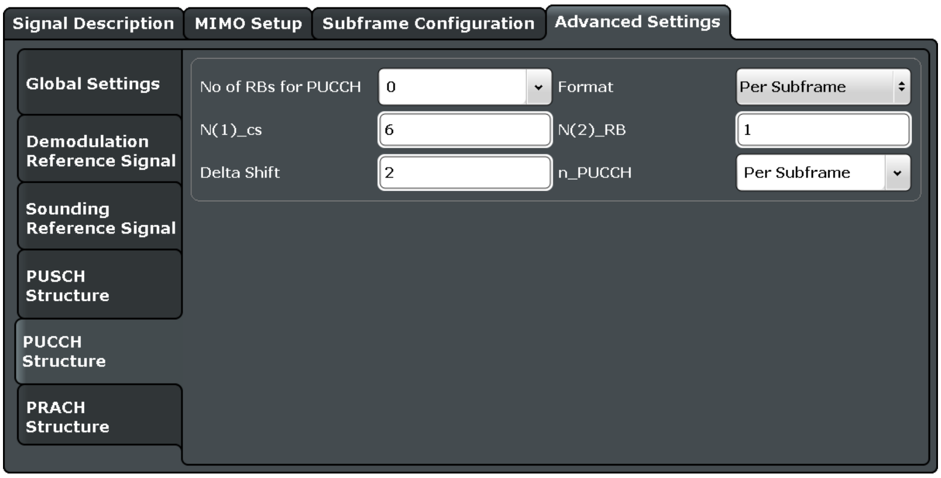
For more information on PUSCH frequency hopping refer to 3GPP TS36.213.

Remote command:
`CONFigure[:LTE]:UL[:CC<cci>]:PUSCh:FHOP:IIHB` on page 163

4.2.8 Defining the PUCCH Structure

The PUCCH structure settings contain settings that describe the physical attributes and structure of the PUCCH.

The PUCCH structure settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



No. of RBs for PUCCH

Defines the number of resource blocks reserved for PUCCH.

The resource blocks for PUCCH are always allocated at the edges of the LTE spectrum.

In case of an even number of PUCCH resource blocks, half of the available PUCCH resource blocks is allocated on the lower, the other half on the upper edge of the LTE spectrum (outermost resource blocks).

In case of an odd number of PUCCH resource blocks, the number of resource blocks on the lower edge is one resource block larger than the number of resource blocks on the upper edge of the LTE spectrum.

If you select the "Auto" menu item, the application automatically detects the number of RBs.

Remote command:
`CONFigure[:LTE]:UL:PUCCh:NORB` on page 165

N(1)_cs

Defines the number of cyclic shifts used for PUCCH format 1/1a/1b in a resource block used for a combination of the formats 1/1a/1b and 2/2a/2b.

Only one resource block per slot can support a combination of the PUCCH formats 1/1a/1b and 2/2a/2b.

The number of cyclic shifts available for PUCCH format 2/2a/2b N(2)_cs in a block with combination of PUCCH formats is calculated as follows.

N(2)_cs = 12 - N(1)_cs - 2

For more information refer to 3GPP TS36.211, chapter 5.4 "Physical Uplink Control Channel".

Remote command:
`CONFigure[:LTE]:UL:PUCCh:N1CS` on page 165

Delta Shift
Defines the delta shift parameter.

The delta shift is the difference between two adjacent PUCCH resource indices with the same orthogonal cover sequence (OC).

It determines the number of available sequences in a resource block that can be used for PUCCH formats 1/1a/1b.

For more information refer to 3GPP TS36.211, chapter 5.4 "Physical Uplink Control Channel".

Remote command:
`CONFigure[:LTE]:UL:PUCCh:DESHift` on page 164

Format
Selects the format of the PUCCH.

You can define the PUCCH format for all subframes or define the PUCCH format for each subframe individually.

- F1, F1a, F1b, F2, F2a, F2b, F3
  Selects the PUCCH format globally for every subframe.
- Per Subframe
  You can select the PUCCH format for each subframe separately in the Enhanced Settings of the "Subframe Configuration".

Note that formats F2a and F2b are only supported for normal cyclic prefix length.

For more information refer to 3GPP TS36.211, table 5.4-1 "Supported PUCCH Formats".

Remote command:
`CONFigure[:LTE]:UL:PUCCh:FORMat` on page 164

N(2)_RB
Defines bandwidth in terms of resource blocks that are reserved for PUCCH formats 2/2a/2b transmission in each subframe.

Since there can be only one resource block per slot that supports a combination of the PUCCH formats 1/1a/1b and 2/2a/2b, the number of resource block(s) per slot available for PUCCH format 1/1a/1b is determined by N(2)_RB.

For more information refer to 3GPP TS36.211, chapter 5.4 "Physical Uplink Control Channel".

Remote command:
`CONFigure[:LTE]:UL:PUCCh:N2RB` on page 165

N_PUCCH
Defines the resource index for PUCCH format 1/1a/1b respectively 2/2a/2b.

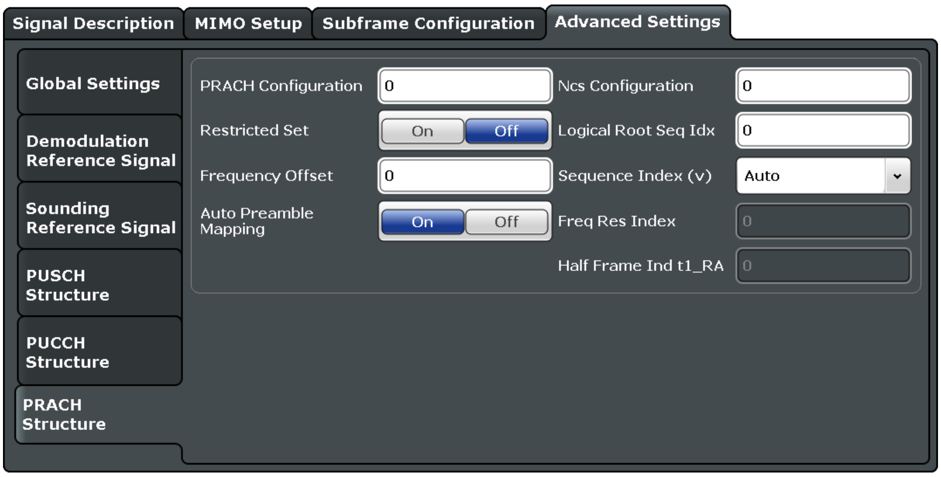
It is also possible to define N_{PUCCH} on a subframe level by selecting the "Per Subframe" menu item. For more information see chapter 4.2.3, "Configuring Subframes", on page 49.

Remote command:
CONFigure[:LTE]:UL:PUCCh:NPAR on page 166

4.2.9 Defining the PRACH Structure

The PRACH structure settings contain settings that describe the physical attributes and structure of the PUCCH.

The PRACH structure settings are part of the "Advanced Settings" tab of the "Signal Description" dialog box.



PRACH Configuration
Sets the PRACH configuration index as defined in the 3GPP TS 36.211, i.e. defines the subframes in which random access preamble transmission is allowed.

The preamble format is automatically derived form the PRACH Configuration.

Remote command:
CONFigure[:LTE]:UL:PRACh:CONF on page 167

Restricted Set
Selects whether a restricted preamble set (high speed mode) or the unrestricted preamble set (normal mode) will be used.

Remote command:
CONFigure[:LTE]:UL:PRACh:RSET on page 168

Frequency Offset
For preamble formats 0-3, sets the PRACH Frequency Offset as defined in the 3GPP TS 36.211, i.e. determines the first physical resource block available for PRACH expressed as a physical resource block number.

Remote command:
`CONFigure[:LTE]:UL:PRACh:FOFFset` on page 167

PRACH Preamble Mapping
The frequency resource index f_{RA} and the half frame indicator $t1_{RA}$ are neccessary to clearly specify the physical resource mapping of the PRACH in case a PRACH configuration index has more than one mapping alternative.

If you turn on the "Auto Preamble Mapping", the software automatically detects f_{RA} and $t1_{RA}$.

The values for both parameters are defined in table '5.7.1-4: Frame structure type 2 random access preamble mapping in time and frequency' (3GPP TS 36.211 v10.2.0).

The frequency resource index and half frame indicator are available in TDD mode.

Remote command:
`CONFigure[:LTE]:UL:PRACh:APM` on page 166
`CONFigure[:LTE]:UL:PRACh:FRINdex` on page 167
`CONFigure[:LTE]:UL:PRACh:HFINdicator` on page 167

Ncs Conf
Selects the Ncs configuration, i.e. determines the Ncs value set according to TS 36.211, table 5.7.2.-2 and 5.7.2-3.

Remote command:
`CONFigure[:LTE]:UL:PRACh:NCSC` on page 167

Logical Root Sequ. Idx
Selects the logical root sequence index.

The logical root sequence index is used to generate preamble sequences. It is provided by higher layers.

Remote command:
`CONFigure[:LTE]:UL:PRACh:RSEQ` on page 168

Sequence Index (v)
Defines the sequence index (v).

The sequence index controls which of the 64 preambles available in a cell is used.

If you select the "Auto" menu item, the software automatically selects the required sequence index.

Remote command:
`CONFigure[:LTE]:UL:PRACh:SINDex` on page 168

4.2.10 Selecting the Input and Output Source

The application supports several input sources and outputs.

For a comprehensive description of the supported inputs and outputs, please refer also to the documentation of the R&S FSW base unit.

4.2.10.1 RF Input

Functions to configure the RF input described elsewhere:

- "Input Coupling" on page 74
- "Impedance" on page 74

Direct Path

Enables or disables the use of the direct path for small frequencies.

In spectrum analyzers, passive analog mixers are used for the first conversion of the input signal. In such mixers, the LO signal is coupled into the IF path due to its limited isolation. The coupled LO signal becomes visible at the RF frequency 0 Hz. This effect is referred to as LO feedthrough.

To avoid the LO feedthrough the spectrum analyzer provides an alternative signal path to the A/D converter, referred to as the *direct path*. By default, the direct path is selected automatically for RF frequencies close to zero. However, this behavior can be deactivated. If "Direct Path" is set to "Off", the spectrum analyzer always uses the analog mixer path.

"Auto"	(Default) The direct path is used automatically for frequencies close to zero.
"Off"	The analog mixer path is always used.

Remote command:
`INPut:DPATh` on page 173

High-Pass Filter 1...3 GHz

Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the analyzer in order to measure the harmonics for a DUT, for example.

This function requires an additional hardware option.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG filter.)

Remote command:
`INPut:FILTer:HPASs[:STATe]` on page 173

YIG-Preselector

Activates or deactivates the YIG-preselector, if available on the R&S FSW.

An internal YIG-preselector at the input of the R&S FSW ensures that image frequencies are rejected. However, this is only possible for a restricted bandwidth. In order to use the maximum bandwidth for signal analysis you can deactivate the YIG-preselector at the input of the R&S FSW, which may lead to image-frequency display.

Note that the YIG-preselector is active only on frequencies greater than 8 GHz. Therefore, switching the YIG-preselector on or off has no effect if the frequency is below that value.

Remote command:
`INPut:FILTer:YIG[:STATe]` on page 174

Input Connector

Determines whether the RF input data is taken from the RF INPUT connector (default) or the optional BASEBAND INPUT I connector. This setting is only available if the optional Analog Baseband Interface is installed and active for input. It is not available for the R&S FSW67 or R&S FSW85.

For more information on the Analog Baseband Interface (R&S FSW-B71) see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

Remote command:
`INPut:CONNector` on page 170

4.2.10.2 Digital I/Q Input

The functionality of the Digital I/Q input is available with option R&S FSW-B17.

Digital I/Q Input State

Enables or disable the use of the "Digital IQ" input source for measurements.

"Digital IQ" is only available if the optional Digital Baseband Interface is installed.

Remote command:
`INPut:SELect` on page 175

Input Sample Rate

Defines the sample rate of the digital I/Q signal source. This sample rate must correspond with the sample rate provided by the connected device, e.g. a generator.

If "Auto" is selected, the sample rate is adjusted automatically by the connected device.

The allowed range is from 100 Hz to 10 GHz.

Remote command:
`INPut:DIQ:SRATe` on page 172
`INPut:DIQ:SRATe:AUTO` on page 173

Full Scale Level
The "Full Scale Level" defines the level and unit that should correspond to an I/Q sample with the magnitude "1".

If "Auto" is selected, the level is automatically set to the value provided by the connected device.

Remote command:
`INPut:DIQ:RANGe[:UPPer]` on page 172
`INPut:DIQ:RANGe[:UPPer]:UNIT` on page 172
`INPut:DIQ:RANGe[:UPPer]:AUTO` on page 171

Adjust Reference Level to Full Scale Level
If enabled, the reference level is adjusted to the full scale level automatically if any change occurs.

Remote command:
`INPut:DIQ:RANGe:COUPling` on page 172

Connected Instrument
Displays the status of the Digital Baseband Interface connection.

If an instrument is connected, the following information is displayed:

- Name and serial number of the instrument connected to the Digital Baseband Interface
- Used port
- Sample rate of the data currently being transferred via the Digital Baseband Interface
- Level and unit that corresponds to an I/Q sample with the magnitude "1" (Full Scale Level), if provided by connected instrument

Remote command:
`INPut:DIQ:CDEVice` on page 170

DigIConf
Starts the optional R&S DigIConf application. This function is available in the In-/Output menu, but only if the optional software is installed.

Note that R&S DigIConf requires a USB connection (not LAN!) from the R&S FSW to the R&S EX-IQ-BOX in addition to the Digital Baseband Interface connection. R&S DigIConf version 2.20.360.86 Build 170 or higher is required.

To return to the R&S FSW application, press any key. The R&S FSW application is displayed with the "Input/Output" menu, regardless of which key was pressed.

For details on the R&S DigIConf application, see the "R&S®EX-IQ-BOX Digital Interface Module R&S®DigIConf Software Operating Manual".

Note: If you close the R&S DigIConf window using the "Close" icon, the window is minimized, not closed.

If you select the "File > Exit" menu item in the R&S DigIConf window, the application is closed. Note that in this case the settings are lost and the EX-IQ-BOX functionality is no longer available until you restart the application using the "DigIConf" softkey in the R&S FSW once again.

4.2.10.3 Analog Baseband

The functionality of the Analog Baseband input is available with option R&S FSW-B71.

Analog Baseband Input State
Enables or disable the use of the "Analog Baseband" input source for measurements. "Analog Baseband" is only available if the optional Analog Baseband Interface is installed.

Remote command:
`INPut:SELect` on page 175

I/Q Mode
Defines the format of the input signal.

For more information on I/Q data processing modes see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

"I + jQ" The input signal is filtered and resampled to the sample rate of the application.
Two inputs are required for a complex signal, one for the in-phase component, and one for the quadrature component.

"I Only / Low IF I"
The input signal at the BASEBAND INPUT I connector is filtered and resampled to the sample rate of the application.
If the center frequency is set to 0 Hz, the real baseband signal is displayed without down-conversion (**Real Baseband I**).
If a center frequency greater than 0 Hz is set, the input signal is down-converted with the center frequency (**Low IF I**).

"Q Only / Low IF Q"
The input signal at the BASEBAND INPUT Q connector is filtered and resampled to the sample rate of the application.
If the center frequency is set to 0 Hz, the real baseband signal is displayed without down-conversion (**Real Baseband Q**).
If a center frequency greater than 0 Hz is set, the input signal is down-converted with the center frequency (**Low IF Q**).

Remote command:
`INPut:IQ:TYPE` on page 174

Input Configuration
Defines whether the input is provided as a differential signal via all four Analog Baseband connectors or as a plain I/Q signal via two simple-ended lines.

Note: Both single-ended and differential probes are supported as input; however, since only one connector is occupied by a probe, the "Single-ended" setting must be used for all probes.

"Single Ended"	I, Q data only
"Differential"	I, Q and inverse I,Q data (Not available for R&S FSW85)

Remote command:
`INPut:IQ:BALanced[:STATe]` on page 174

High Accuracy Timing Trigger - Baseband - RF
Activates a mode with enhanced timing accuracy between analog baseband, RF and external trigger signals.

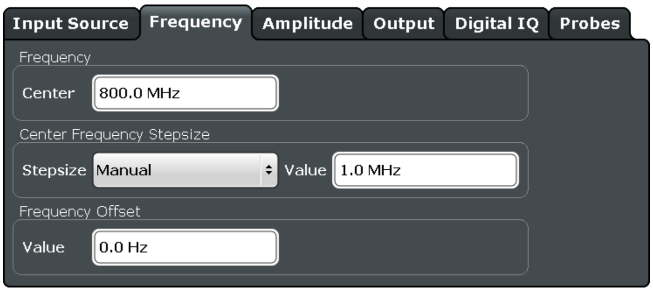
Note: Prerequisites for previous models of R&S FSW.
For R&S FSW models with a serial number lower than 103000, special prerequisites and restrictions apply for high accuracy timing:
- To obtain this high timing precision, trigger port 1 and port 2 must be connected via the Cable for High Accuracy Timing (order number 1325.3777.00).
- As trigger port 1 and port 2 are connected via the cable, only trigger port 3 can be used to trigger a measurement.
- Trigger port 2 is configured as output if the high accuracy timing option is active. Make sure not to activate this option if you use trigger port 2 in your measurement setup.
- When you first enable this setting, you are prompted to connect the cable for high accuracy timing to trigger ports 1 and 2. If you cancel this prompt, the setting remains disabled. As soon as you confirm this prompt, the cable must be in place - the firmware does not check the connection. (In remote operation, the setting is activated without a prompt.)

For more information see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

Remote command:
`CALibration:AIQ:HATiming[:STATe]` on page 169

4.2.11 Defining the Frequency

Frequency settings define the frequency characteristics of the signal at the RF input. They are part of the "Frequency" tab of the "Signal Characteristics" dialog box.



Defining the Signal Frequency

For measurements with an RF input source, you have to match the **center frequency** of the analyzer to the frequency of the signal.

The available frequency range depends on the hardware configuration of the analyzer you are using.

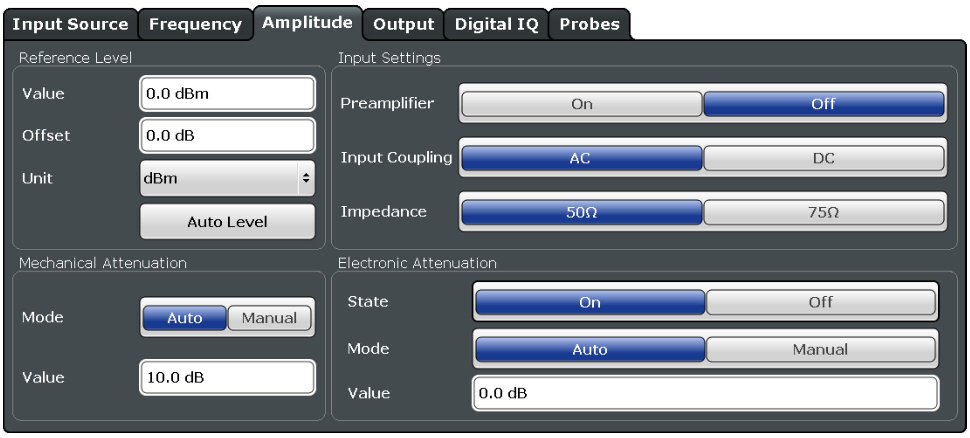
In addition to the frequency itself, you can also define a frequency stepsize. The frequency stepsize defines the extent of a frequency change if you change it for example with the rotary knob. Define the stepsize in two ways.

- = Center
  One frequency step corresponds to the current center frequency.
- Manual
  Define a any stepsize you need.

Remote command:
Center frequency: `[SENSe]:FREQuency:CENTer[:CC<cci>]` on page 176
Frequency stepsize: `[SENSe:]FREQuency:CENTer:STEP` on page 177
Frequency offset: `[SENSe]:FREQuency:CENTer[:CC<cci>]:OFFSet` on page 176

4.2.12 Defining Level Characteristics

Amplitude settings define the expected level characteristics of the signal at the RF input.



Defining a Reference Level

The reference level is the power level the analyzer expects at the RF input. Keep in mind that the power level at the RF input is the peak envelope power in case of signals with a high crest factor like LTE.

To get the best dynamic range, you have to set the reference level as low as possible. At the same time, make sure that the maximum signal level does not exceed the reference level. If it does, it will overload the A/D converter, regardless of the signal power. Measurement results may deteriorate (e.g. EVM). This applies especially for measurements with more than one active channel near the one you are trying to measure (± 6 MHz).

Note that the signal level at the A/D converter may be stronger than the level the application displays, depending on the current resolution bandwidth. This is because the resolution bandwidths are implemented digitally after the A/D converter.

You can specify the reference level in several **units** and define an arithmetic **level offset**. A level offset is useful if the signal is attenuated or amplified before it is fed into the analyzer. All displayed power level results will be shifted by this value. Note however, that the reference value ignores the level offset. Thus, it is still mandatory to define the actual power level that the analyzer has to handle as the reference level.

You can also use **automatic detection** of the reference level with the "Auto Level" function.

If active, the application measures and sets the reference level to its ideal value.

Automatic level detection also optimizes RF attenuation.

The application shows the current reference level (including RF and external attenuation) in the channel bar.

Remote command:
Manual: `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel` on page 178
Automatic: `[SENSe:]ADJust:LEVel` on page 182
Offset: `DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet` on page 179
Unit: `CALCulate<n>:UNIT:POWer` on page 178

Attenuating the Signal

Attenuation of the signal may become necessary if you have to reduce the power of the signal that you have applied. Power reduction is necessary, for example, to prevent an overload of the input mixer.

The LTE measurement application provides several attenuation modes.

- **Mechanical** (or RF) attenuation is always available. The mechanical attenuator controls attenuation at the RF input.

- It is also possible to equip the R&S FSW with the optional **electronic** attenuator. Note that the frequency range may not exceed the specification of the electronic attenuator for it to work.
  For both methods, the application provides **automatic** detection of the ideal attenuation level. Alternatively, you can define the attenuation level **manually**. The range is from 0 dB to 79 dB (RF attenuation) or 30 dB (electronic attenuation) in 1 dB steps.

For more information on attenuating the signal see the manual of the connected instrument.

The application shows the attenuation level (mechanical and electronic) in the channel bar.

Remote command:
RF attenuation: `INPut:ATTenuation` on page 179
RF attenuation: `INPut:ATTenuation:AUTO` on page 179
Electronic attenuation: `INPut<n>:EATT:STATe` on page 182
Electronic attenuation: `INPut<n>:EATT:AUTO` on page 181
Electronic attenuation: `INPut<n>:EATT` on page 181

Input Coupling

The RF input of the R&S FSW can be coupled by alternating current (AC) or direct current (DC).

This function is not available for input from the optional Digital Baseband Interface or from the optional Analog Baseband Interface.

AC coupling blocks any DC voltage from the input signal. This is the default setting to prevent damage to the instrument. Very low frequencies in the input signal may be distorted.

However, some specifications require DC coupling. In this case, you must protect the instrument from damaging DC input voltages manually. For details, refer to the data sheet.

Remote command:
`INPut:COUPling` on page 180

Impedance

For some measurements, the reference impedance for the measured levels of the R&S FSW can be set to 50 Ω or 75 Ω.

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

This value also affects the unit conversion.

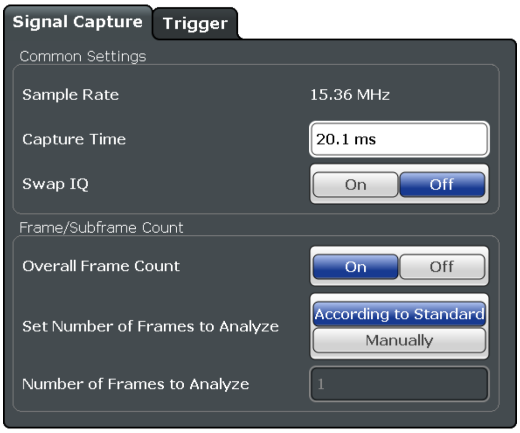
This function is not available for input from the optional Digital Baseband Interface or from the optional Analog Baseband Interface . For analog baseband input, an impedance of 50 Ω is always used.

Remote command:
`INPut:IMPedance` on page 181

4.2.13 Configuring the Data Capture

The data capture settings contain settings that control the data capture.

The data capture settings are part of the "Signal Capture" tab of the "Trigger/Signal Capture" dialog box.



Capture Time

Defines the capture time.

The capture time corresponds to the time of one measurement. Hence, it defines the amount of data the application captures during a single measurement (or sweep).

By default, the application captures 20.1 ms of data to make sure that at least one complete LTE frame is captured in the measurement.

The application shows the current capture time in the channel bar.

Remote command:
`[SENSe]:SWEep:TIME` on page 184

Swap I/Q

Swaps the real (I branch) and the imaginary (Q branch) parts of the signal.

Remote command:
`[SENSe]:SWAPiq` on page 183

Overall Frame Count

Turns the manual selection of the number of frames to capture (and analyze) on and off.

If the overall frame count is active, you can define a particular number of frames to capture and analyze. The measurement runs until all required frames have been analyzed, even if it takes more than one sweep. The results are an average of the captured frames.

If the overall frame count is inactive, the application analyzes all complete LTE frames currently in the capture buffer.

The application shows the current frame count in the channel bar.

Remote command:
`[SENSe][:LTE]:FRAMe:COUNt:STATe` on page 183

Auto According to Standard

Turns automatic selection of the number of frames to capture and analyze on and off.

If active, the application evaluates the number of frames as defined for EVM tests in the LTE standard.

If inactive, you can set the number of frames you want to analyze.

This parameter is not available if the overall frame count is inactive.

Remote command:
`[SENSe][:LTE]:FRAMe:COUNt:AUTO` on page 183

Number of Frames to Analyze

Sets the number of frames that you want to capture and analyze.

If the number of frames you have set last longer than a single measurement, the application continues the measurement until all frames have been captured.

The parameter is read only if

- the overall frame count is inactive,
- the data is captured according to the standard.

Remote command:
`[SENSe][:LTE]:FRAMe:COUNt` on page 182

4.2.14 Triggering Measurements

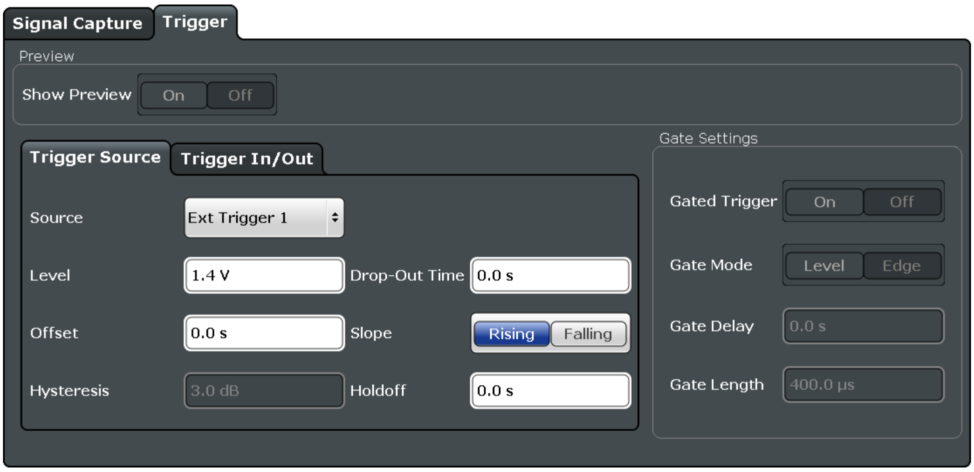
The trigger functionality of the LTE measurement application is the same as that of the R&S FSW. For a comprehensive description of the available trigger settings see the documentation of the R&S FSW.

Note that some trigger sources available in Spectrum mode are not available in the LTE application. Note also that the Preview and Gate functionality are only available for frequency sweep measurements (ACLR and SEM).

Gated frequency sweep measurements

The application automatically selects the correct gate settings (delay and length) according to the TDD configuration.

The trigger settings are part of the "Trigger" tab of the "Trigger/Signal Capture" dialog box.



For more information on triggering measurements see the documentation of the R&S FSW.

4.2.15 Tracking

The tracking settings contain settings that compensate for various common measurement errors that may occur.

Phase

Specifies whether or not the measurement results should be compensated for common phase error. When phase compensation is used, the measurement results will be compensated for phase error on a per-symbol basis.

"Off"	Phase tracking is not applied.
"Pilot Only"	Only the reference signal is used for the estimation of the phase error.
"Pilot and Payload"	Both reference signal and payload resource elements are used for the estimation of the phase error.

Remote command:

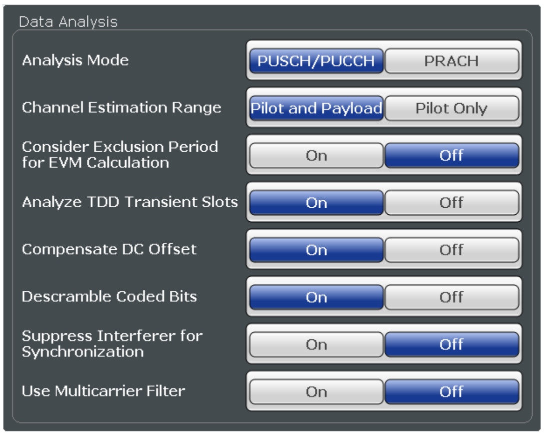
`[SENSe][:LTE]:UL:TRACking:PHASe` on page 189

Timing

Specifies whether or not the measurement results should be compensated for timing error. When timing compensation is used, the measurement results will be compensated for timing error on a per-symbol basis.

Remote command:
`[SENSe][:LTE]:UL:TRACking:TIME` on page 189

4.2.16 Signal Demodulation



Analysis Mode

Selects the channel analysis mode.

You can select from "PUSCH/PUCCH" mode and "PRACH" mode.

PUSCH/PUCCH mode analyzes the PUSCH and PUCCH. This is the default.

PRACH mode analyzes the PRACH only. In PRACH analysis mode no subframe or slot selection is available. Instead you can select a particular preamble that the results are shown for. Note that PRACH analysis mode does not support all result displays.

Remote command:
`[SENSe][:LTE]:UL:DEMod:MODE` on page 187

Channel Estimation Range

Selects the method for channel estimation.

You can select if only the pilot symbols are used to perform channel estimation or if both pilot and payload carriers are used.

Remote command:
[SENSe][:LTE]:UL:DEMod:CESTimation on page 187

EVM with Exclusion Period
Turns exclusion periods for EVM measurements as defined in 3GPP TS 36.521 on and off.

The exclusion period affects the PUSCH data EVM of the first and last symbol.

The software automatically determines the length of the exclusion period according to 3GPP TS 36.521-1.

The exclusion period has no effect on the EVM vs Carrier and EVM vs Symbol x Carrier result displays.

Remote command:
[SENSe][:LTE]:UL:DEMod:EEPeriod on page 188

Analyze TDD Transient Slots
Includes or excludes the transient slots present after a switch from downlink to uplink in the analysis.

If on, the transient slots are not included in the measurement.

Remote command:
[SENSe][:LTE]:UL:DEMod:ATTSlots on page 187

Compensate DC Offset
Turns DC offset compensation when calculating measurement results on and off.

According to 3GPP TS 36.101 (Annex F.4), the R&S FSW removes the carrier leakage (I/Q origin offset) from the evaluated signal before it calculates the EVM and in-band emissions.

Remote command:
[SENSe][:LTE]:UL:DEMod:CDCoffset on page 188

Scrambling of Coded Bits
Turns the scrambling of coded bits for the PUSCH on and off.

The scrambling of coded bits affects the bitstream results.

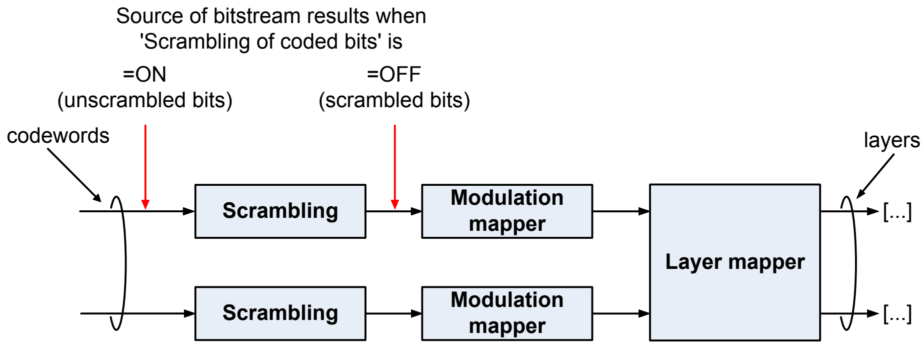


Fig. 4-1: Source for bitstream results if scrambling for coded bits is on and off

Remote command:
`[SENSe][:LTE]:UL:DEMod:CBSCrambling` on page 188

Suppressed Interference Synchronization
Turns suppressed interference synchronization on and off.

If active, the synchronization on signals containing more than one user equipment (UE) is more robust. Additionally, the EVM is lower in case the UEs have different frequency offsets. Note that Auto Demodulation is not supported in this synchronization mode and the EVM may be higher in case only one UE is present in the signal.

Remote command:
`[SENSe][:LTE]:UL:DEMod:SISYnc` on page 188

Multicarrier Filter
Turns the suppression of interference of neighboring carriers on and off.

Remote command:
`[SENSe][:LTE]:UL:DEMod:MCFilter` on page 189

4.3 Configuring Time Alignment Error Measurements

Several settings supported by Time Alignment Error measurements are the same as those for I/Q measurements. For a comprehensive description of those, refer to the following chapters.

- chapter 4.2.1, "Defining Signal Characteristics", on page 44
- chapter 4.2.5, "Configuring the Demodulation Reference Signal", on page 55
- chapter 4.2.7, "Defining the PUSCH Structure", on page 61
- chapter 4.2.10, "Selecting the Input and Output Source", on page 66
- chapter 4.2.11, "Defining the Frequency", on page 71
- chapter 4.2.12, "Defining Level Characteristics", on page 72
- chapter 4.2.13, "Configuring the Data Capture", on page 75
- chapter 4.2.14, "Triggering Measurements", on page 76
- chapter 4.2.16, "Signal Demodulation", on page 78

The application also provides several settings that are exclusive to Time Alignment Error measurements.

Carrier Aggregation
Carrier aggregation has been introduced in the LTE standard to increase the bandwidth. In those systems, several carriers can be used to transmit a signal. Each carrier usually has one of the channel bandwidths defined by 3GPP.

The R&S FSW features several measurements that support contiguous and non-contiguous intra-band carrier aggeregation (the carriers are in the same frequency band).

- Time Alignment Error (downlink)
- Time Alignment Error (uplink)
- Transmit On/Off Power (downlink)
- Cumulative ACLR (downlink, non-contiguous intra-band carrier aggregation)
- Multi Carrier ACLR (downlink, non-contiguous intra-band carrier aggregation)
- Multi Carrier ACLR (uplink, contiguous intra-band carrier aggregation)
- SEM (downlink, non-contiguous intra-band carrier aggregation)
- SEM (uplink, contiguous intra-band carrier aggregation)

The way to configure these measurements is similar (but not identical, the differences are indicated below).

- "Basic component carrier configuration" on page 81
- "Features of the Time Alignment Error measurement" on page 82
- "Features of the MC ACLR measurement" on page 82
- "Remote commands to configure carrier aggregation" on page 83

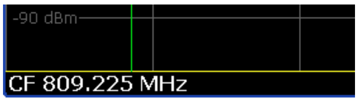
Basic component carrier configuration ← Carrier Aggregation
The number of component carriers (CCs) you can select depends on the measurement.

- Time Alignment Error: up to 2 CCs
- Multi-carrier ACLR: 2 CCs (fix value)
- SEM: up to 2 CCs

The **center frequency** defines the carrier frequency of the carriers, each with a certain **bandwidth** that you can select from the corresponding dropdown menu. For all component carriers, the application also shows the **frequency offset** relative to the center frequency of the first carrier.

Note that the application automatically calculates the frequency and offset of the second (or subsequent) carrier according to the 3GPP specification.

Note that the actual measurement frequency differs from the two carrier frequencies: the application calculates that frequency based on the carrier frequencies. It is somewhere in between the carrier frequencies. The measurement frequency is displayed at the bottom of the diagram area.



Selecting the **channel bandwidths** of each carrier is possible in two ways.

- Predefined bandwidth combinations
  Select a typical combination of channel bandwidths from the dropdown menu.
  This way, you just have to define the center frequency of the first carrier. The application calculates the rest of the frequency characteristics.
- User Defined
  Select "User Defined" from the dropdown menu to test a system with channel bandwidths not in the list of predefined combinations.
  When you select a user defined combination, you can select the channel bandwidth for each carrier from the "Bandwidth" dropdown menus.

When the defined carrier configuration is not supported by the application, a corresponding error message is displayed. This may be the case, for example, if the carriers occupy a bandwidth that is too large.

Features of the Time Alignment Error measurement ← Carrier Aggregation
Note that the TAE measurements are possible on one R&S FSW only. Therefore the number of devices to measure is always "1".

You can configure additional signal characteristics of the first and second carrier in the "CC1" and "CC2" tabs.

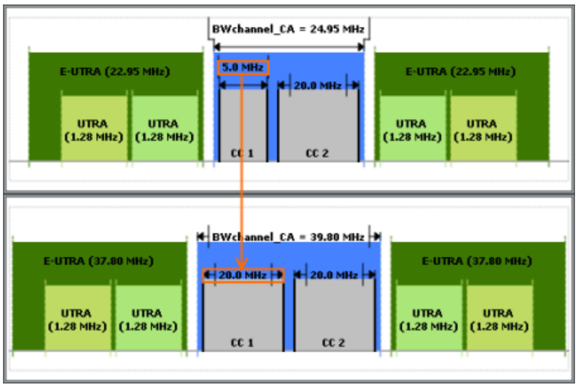
More information

In case you are testing a MIMO DUT, you can also select the number of antennas the DUT supports. When you select "1 Tx Antenna", the application measures the timing difference between two SISO carriers, when you select more than one antenna, it measures the timing difference between the antennas. In that case, you can select the reference antenna from the dropdown menu in the Time Alignment Error result display.

Note that the application shows measurement results for the second component carrier even if only one antenna of the second component carrier is attached (i.e. no combiner is used).

Features of the MC ACLR measurement ← Carrier Aggregation
The diagram at the bottom of the dialog box represents the current configuration. When you change the bandwidth of a carrier (represented by blue bars), the application adjusts the bandwidth of the carriers in the diagram accordingly.

The characteristics of the neighboring channels in the MC ACLR measurement are defined in 3GPP 36.251 (represented by green bars).



Remote commands to configure carrier aggregation ← Carrier Aggregation

Remote command:
Number of carriers: `CONFigure:NOCC` on page 190
Carrier frequency: `[SENSe]:FREQuency:CENTer[:CC<cci>]` on page 176
Measurement frequency: `SENSe:FREQuency:CENTer?`
Offset: `[SENSe]:FREQuency:CENTer[:CC<cci>]:OFFSet` on page 176
Channel bandwidth: `CONFigure[:LTE]:UL:CABW` on page 191
Channel bandwidth: `CONFigure[:LTE]:UL[:CC<cci>]:BW` on page 148
Number of devices: `CONFigure[:LTE]:NDEV` on page 191

4.4 Configuring Frequency Sweep Measurements

After starting one of the frequency sweep measurements, the application automatically loads the configuration required by measurements according to the 3GPP standard: the spectral mask as defined in the 3GPP standard for SEM measurements and the channel configuration defined in the standard for the ACLR measurement.

If you need a different measurement configuration, you can change all parameters as required. Except for the dialog box decribed below, the measurement configuration menus for the frequency sweep measurements are the same as in the Spectrum application.

Please refer to the User Manual of the R&S FSW for a detailed description on how to configure ACLR and SEM measurements.

4.4.1 ACLR Signal Description

The signal description for ACLR measurements contains settings to describe general physical characteristics of the signal you are measuring.

► Press the MEAS CONFIG key.

► Press the "Signal Description" softkey.

The application opens the "Signal Description" dialog box.

For more information on the LTE Mode, Test Model and Channel Bandwidth see "Selecting the LTE Mode" on page 45, "Using Test Models" on page 45 and "Channel Bandwidth / Number of Resource Blocks" on page 46.

Assumed Adjacent Channel Carrier
Selects the assumed adjacent channel carrier for the ACLR measurement.

The supported types are EUTRA of same bandwidth, 1.28 Mcps UTRA, 3.84 Mcps UTRA and 7.68 Mcps UTRA.

Note that not all combinations of LTE Channel Bandwidth settings and Assumed Adj. Channel Carrier settings are defined in the 3GPP standard.

Remote command:
`[SENSe]:POWer:ACHannel:AAChannel` on page 192

4.4.2 SEM Signal Description

The signal description for SEM measurements contains settings to describe general physical characteristics of the signal you are measuring.

► Press the MEAS CONFIG key.

► Press the "Signal Description" softkey.

The application opens the "Signal Description" dialog box.

For more information on the LTE Mode, Test Model, Channel Bandwidth and Cyclic Prefix see "Selecting the LTE Mode" on page 45, "Using Test Models" on page 45, "Channel Bandwidth / Number of Resource Blocks" on page 46 and "Cyclic Prefix" on page 46.

SEM Requirement
Selects the type of spectrum emission mask used for the Out of Band emission measurement.

The software supports general and specific (additional) spectrum emission masks. The specific spectrum emission masks contain additional SEM requirements. The additional requirements masks to use for the measurement depend on the network signalled value "NS_03", "NS_04", "NS_06" or "NS_07".

If "NS_06" or "NS_07" is indicated in the cell, use SEM requirement "NS_06_07".

Remote command:
`[SENSe]:POWer:SEM:UL:REQuirement` on page 192

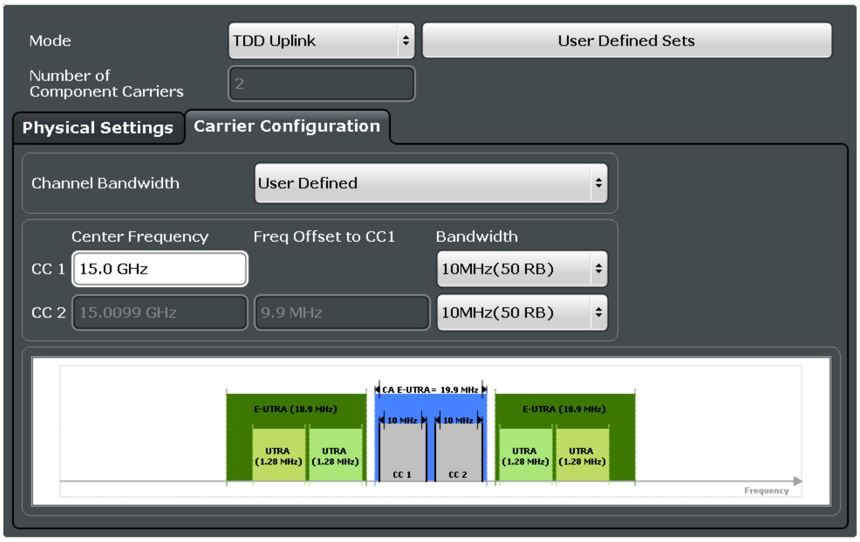
4.4.3 MC ACLR Signal Description

The signal description for MC ACLR measurements contain settings to describe general physical characteristics of the signal you are measuring.

► Press the MEAS CONFIG key.

► Press the "Signal Description" softkey.

  The application opens the "Signal Description" dialog box.
  You can configure the characteristics of the carriers in the "Carrier Configuration" tab.
  Note: the "Carrier Configuration" button in the "Physical Settings" tab also opens the "Carrier Configuration" tab.



For more information on the LTE Mode, Test Model, Channel Bandwidth and Cyclic Prefix see "Selecting the LTE Mode" on page 45, "Using Test Models" on page 45, "Channel Bandwidth / Number of Resource Blocks" on page 46 and "Cyclic Prefix" on page 46.

For more information about configuring carrier aggregation see "Carrier Aggregation" on page 81.

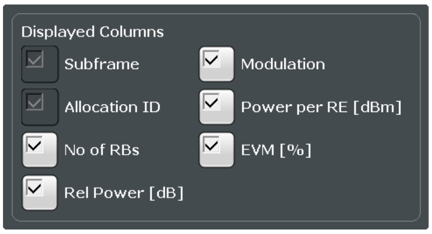
5 Analysis

5.1 Configuring Tables / Numerical Results

The application allows you to customize the number of columns for some numeric result displays, for example the Allocation Summary.

► Tap somewhere in the header row of the table.

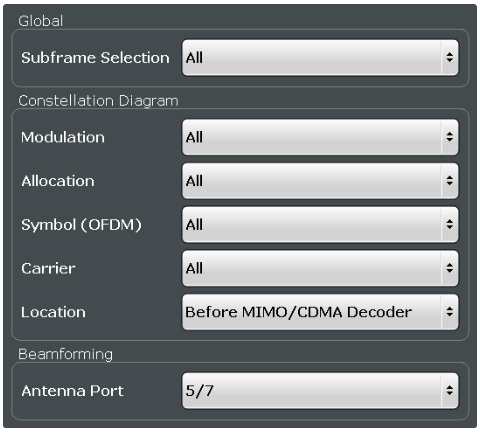
The application opens a dialog box to add or remove columns.



5.2 Analyzing I/Q Measurements

5.2.1 Evaluation Range

The evaluation range defines the signal parts that are considered during signal analysis.



Subframe Selection

Selects a particular subframe whose results the application displays.

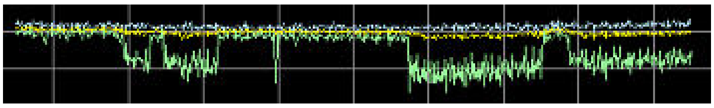
You can select a particular subframe for the following measurements.

- Result Summary
- EVM vs Carrier / EVM vs Symbol / EVM vs Symbol X Carrier
- Spectrum Flatness / Spectrum Flatness SRS / Spectrum Flatness Difference
- Inband Emission
- Group Delay
- Power vs Symbol X Carrier
- Constellation Diagram
- DFT Precoded Constellation
- Allocation Summary
- Bit Stream
- Time Alignment Error

Selecting "All" either displays the results over all subframes or calculates a statistic over all subframes that have been analyzed.

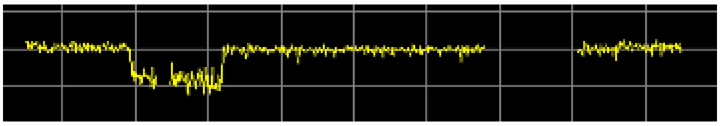
Example: Subframe selection

If you select all subframes ("All"), the application shows three traces. One trace shows the subframe with the minimum level characteristics, the second trace shows the subframe with the maximum level characteristics and the third subframe shows the averaged level characteristics of all subframes.



- PK: peak value
- AV: average value
- MI: minimum value

If you select a specific subframe, the application shows one trace. This trace contains the results for that subframe only.



Remote command:
[SENSe][:LTE]:SUBFrame:SELect on page 195

Slot Selection

Selects a particular slot whose measurement results you want to see.

You can select a particular slot for the following measurements.

Result Summary, EVM vs Carrier, EVM vs Symbol, EVM vs Symbol x Carrier, Inband Emission, Channel Flatness, Spectrum Flatness SRS, Channel Group Delay, Spectrum Flatness Difference, Power vs Symbol x Carrier, Constellation Diagram, DFT Precoded Constellation Diagram and Time Alignment.

In PRACH analysis mode, you can not select a particular slot.

Remote command:
[SENSe][:LTE]:SLOT:SELect on page 195

Preamble Selection

Selects a particular preamble for measurements that analyze individual preambles.

Selecting preambles is available in PRACH analysis mode.

Remote command:
[SENSe][:LTE]:PREamble:SELect on page 194

Evaluation Range for the Constellation Diagram

The "Evaluation Range" dialog box defines the type of constellation points that are displayed in the Constellation Diagram.

By default the application displays all constellation points of the data that have been evaluated. However, you can filter the results by several aspects.

- Modulation

Filters the results to include only the selected type of modulation.
- Allocation
  Filters the results to include only a particular type of allocation.
- Symbol
  Filters the results to include only a particular OFDM symbol.
- Carrier
  Filters the results to include only a particular subcarrier.

The result display is updated as soon as you make the changes.

Note that the constellation selection is applied to all windows in split screen mode if the windows contain constellation diagrams.

Remote command:
Modulation: `[SENSe][:LTE]:MODulation:SELect` on page 194
Allocation: `[SENSe][:LTE]:ALLocation:SELect` on page 193
Symbol: `[SENSe][:LTE]:SYMBol:SELect` on page 196
Carrier: `[SENSe][:LTE]:CARRier:SELect` on page 194

5.2.2 Scale

Y-Axis Scale
The y-axis scaling determines the vertical resolution of the measurement results. The scaling you select always applies to the currently active screen and the corresponding result display.

Usually, the best way to view the results is if they fit ideally in the diagram area in order to view the complete trace. This is the way the application scales the y-axis if you are using the **automatic scale** function.

But it may become necessary to see a more detailed version of the results. In that case, turn on fixed scaling for the y-axis by defining the **minimum** and **maximum** values displayed on the vertical axis. Possible values and units depend on the result display you want to adjust the scale of.

You can restore the default scale at any time with "Restore Scale".

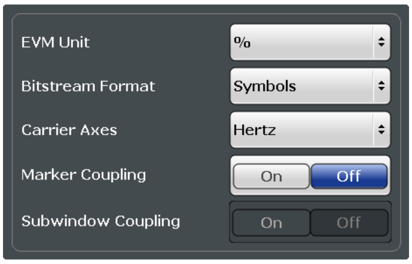
Tip:

Alternatively, you can scale the windows in the "Auto Set" menu. In addition to scaling the window currently in focus ("Auto Scale Window"), there you can scale **all windows** at the same time ("Auto Scale All").

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE` on page 196
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum` on page 196
`DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum` on page 197

5.2.3 Result Settings

Result settings define the way certain measurement results are displayed.



EVM Unit

Selects the unit for graphic and numerical EVM measurement results.

Possible units are dB and %.

Remote command:
`UNIT:EVM` on page 198

Bit Stream Format

Selects the way the bit stream is displayed.

The bit stream is either a stream of raw bits or of symbols. In case of the symbol format, the bits that belong to a symbol are shown as hexadecimal numbers with two digits.

Examples:

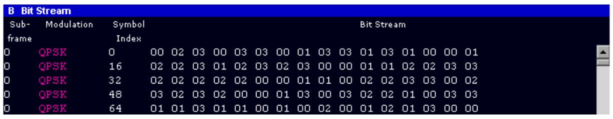


Fig. 5-1: Bit stream display in uplink application if the bit stream format is set to "symbols"

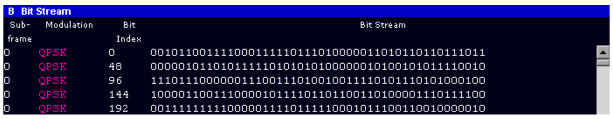


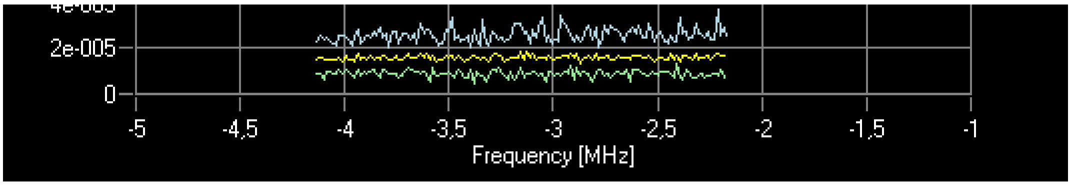
Fig. 5-2: Bit stream display in uplink application if the bit stream format is set to "bits"

Remote command:
`UNIT:BSTR` on page 197

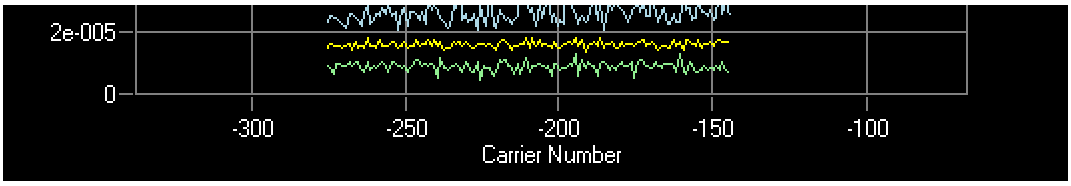
Carrier Axes

Selects the scale of the x-axis for result displays that show results of OFDM subcarriers.

- X-axis shows the frequency of the subcarrier



- X-axis shows the number of the subcarrier



Remote command:
UNIT:CAXes on page 198

Subwindow Coupling
Couples or decouples result display tabs (subwindows).

If the coupling is on and you select another tab in a result display, the application automatically selects the same tab for all result displays

Subwindow coupling is available for measurements with multiple data streams (MIMO).

Marker Coupling
Couples or decouples markers that are active in multiple result displays.

When you turn this feature on, the application moves the marker to its new position in all active result displays.

When you turn it off, you can move the markers in different result displays independent from each other.

Remote command:
CALCulate:MARKer:COUPling on page 197

5.2.4 Markers

Markers are available for most of the I/Q measurement result displays and for the frequency sweep measurements. The functionality (setting and positioning) is the same as in Spectrum mode.

Markers in result displays with a third aspect

In result displays that have a third dimension (EVM vs Symbol x Carrier etc.), you can position a marker on a particular symbol in a particular carrier.

When you activate a marker, you can select the symbol and carrier you want to position the marker on. Alternatively, you can define the marker position in the "Marker Configuration" dialog box, which is expanded accordingly.

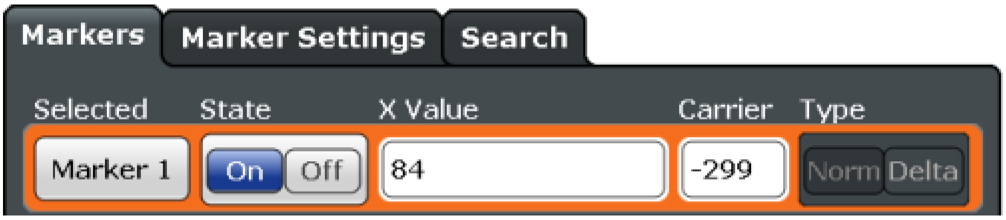


Fig. 5-3: Marker Configuration dialog, the "Carrier" firld is only available for result displays with a third dimension.

For a comprehensive description of the marker functionality see the corresponding chapters in the documentation of the R&S FSW.

5.3 Analyzing Frequency Sweep Measurements

The LTE application supports the same functionality to analyze the results of frequency sweep measurements (Spectrum Emission mask and Adjacent Channel Leakage Ratio) as the R&S FSW base unit does for those measurements.

Please refer to the User Manual of the R&S FSW for a detailed description on how to analyze ACLR and SEM measurements.

6 Remote Control

The following remote control commands are required to configure and perform LTE measurements in a remote environment. The R&S FSW must already be set up for remote operation in a network as described in the base unit manual.

Universal functionality

Note that basic tasks that are also performed in the base unit in the same way are not described here. For a description of such tasks, see the R&S FSW User Manual.

In particular, this includes:

- Managing Settings and Results, i.e. storing and loading settings and result data.
- Basic instrument configuration, e.g. checking the system configuration, customizing the screen layout, or configuring networks and remote operation.
- Using the common status registers (specific status registers for Pulse measurements are not used).

6.1 Overview of Remote Command Suffixes

The remote commands for the LTE Measurement application support the following suffixes.

Suffix	Description
<allocation>	Selects an allocation.
<analyzer>	No effect.
<antenna>	Selects an antenna for MIMO measurements.
<cluster>	Selects a cluster (uplink only).
<cwnum>	Selects a codeword.
<k>	Selects a limit line. Irrelevant for the LTE application.

Suffix	Description
<m>	Selects a marker.
<n>	Selects a measurement window.
<subframe>	Selects a subframe.
<t>	Selects a trace. Irrelevant for the LTE application.

6.2 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a SCPI command consists of a header and, in most cases, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the User Manual of the R&S FSW.

Remote command examples

Note that some remote command examples mentioned in this general introduction may not be supported by this particular application.

6.2.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitely.
- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.

Parameters that are only returned as the result of a query are indicated as **Return values**.

- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S FSW follow the SCPI syntax rules.
- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.
- **Reset values (*RST)**
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as ***RST** values, if available.
- **Default unit**
  This is the unit used for numeric values if no other unit is provided with the parameter.
- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

6.2.2 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

6.2.3 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't quote a suffix for keywords that support one, a 1 is assumed.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

6.2.4 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

`[SENSe:]FREQuency:CENTer` is the same as `FREQuency:CENTer`

With a numeric suffix in the optional keyword:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe`

`DISPlay:ZOOM:STATe ON` enables the zoom in window 1 (no suffix).

`DISPlay:WINDow4:ZOOM:STATe ON` enables the zoom in window 4.

6.2.5 Alternative Keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

6.2.6 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

`LAYout:ADD:WINDow Spectrum,LEFT,MTABle`

Parameters may have different forms of values.

6.2.6.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- MIN/MAX
  Defines the minimum or maximum numeric value that is supported.
- DEF
  Defines the default value.
- UP/DOWN
  Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- INF/NINF
  Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- NAN
  Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

6.2.6.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

6.2.6.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see chapter 6.2.2, "Long and Short Form", on page 95.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

6.2.6.4 Character Strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

`INSTRument:DELete 'Spectrum'`

6.2.6.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

6.3 Remote Commands to Select the LTE Application

INSTrument:CREate:DUPLicate

This command duplicates the currently selected measurement channel, i.e creates a new measurement channel of the same type and with the identical measurement settings. The name of the new channel is the same as the copied channel, extended by a consecutive number (e.g. "IQAnalyzer" -> "IQAnalyzer2").

The channel to be duplicated must be selected first using the `INST:SEL` command.

This command is not available if the MSRA Master channel is selected.

Example: `INST:SEL 'IQAnalyzer'`
`INST:CRE:DUPL`
Duplicates the channel named 'IQAnalyzer' and creates a new measurement channel named 'IQAnalyzer2'.

Usage: Event

INSTrument:CREate[:NEW] <ChannelType>, <ChannelName>

This command adds an additional measurement channel.

The number of measurement channels you can configure at the same time depends on available memory.

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 100.

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 100).

Example: `INST:CRE IQ, 'IQAnalyzer2'`
Adds an additional I/Q Analyzer channel named "IQAnalyzer2".

INSTrument:CREate:REPLace <ChannelName1>,<ChannelType>,<ChannelName2>

This command replaces a measurement channel with another one.

Setting parameters:

<ChannelName1> String containing the name of the measurement channel you want to replace.

<ChannelType> Channel type of the new channel.
For a list of available channel types see `INSTrument:LIST?` on page 100.

<ChannelName2> String containing the name of the new channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see `INSTrument:LIST?` on page 100).

Example: `INST:CRE:REPL 'IQAnalyzer2',IQ,'IQAnalyzer'`
Replaces the channel named 'IQAnalyzer2' by a new measurement channel of type 'IQ Analyzer' named 'IQAnalyzer'.

Usage: Setting only

INSTrument:DELete <ChannelName>

This command deletes a measurement channel.

If you delete the last measurement channel, the default "Spectrum" channel is activated.

Parameters:

<ChannelName> String containing the name of the channel you want to delete.
A measurement channel must exist in order to be able delete it.

Example: `INST:DEL 'IQAnalyzer4'`
Deletes the channel with the name 'IQAnalyzer4'.

Usage: Event

INSTrument:LIST?

This command queries all active measurement channels. This is useful in order to obtain the names of the existing measurement channels, which are required in order to replace or delete the channels.

Return values:

<ChannelType>, <ChannelName> For each channel, the command returns the channel type and channel name (see tables below).
Tip: to change the channel name, use the `INSTrument:REName` command.

Example: `INST:LIST?`
Result for 3 measurement channels:
`'ADEM','Analog Demod','IQ','IQ Analyzer','IQ','IQ Analyzer2'`

Usage: Query only

Table 6-1: Available measurement channel types and default channel names in Signal and Spectrum Analyzer mode

Application	<ChannelType> Parameter	Default Channel Name*)
Spectrum	SANALYZER	Spectrum
I/Q Analyzer	IQ	IQ Analyzer
Pulse (R&S FSW-K6)	PULSE	Pulse
Analog Demodulation (R&S FSW-K7)	ADEM	Analog Demod
GSM (R&S FSW-K10)	GSM	GSM
Multi-Carrier Group Delay (R&S FSW-K17)	MCGD	MC Group Delay
Amplifier Measurements (R&S FSW-K18)	AMPLifier	Amplifier
Noise (R&S FSW-K30)	NOISE	Noise
Phase Noise (R&S FSW-K40)	PNOISE	Phase Noise
Transient Analysis (R&S FSW-K60)	TA	Transient Analysis
VSA (R&S FSW-K70)	DDEM	VSA
3GPP FDD BTS (R&S FSW-K72)	BWCD	3G FDD BTS
3GPP FDD UE (R&S FSW-K73)	MWCD	3G FDD UE
TD-SCDMA BTS (R&S FSW-K76)	BTDS	TD-SCDMA BTS
TD-SCDMA UE (R&S FSW-K77)	MTDS	TD-SCDMA UE
cdma2000 BTS (R&S FSW-K82)	BC2K	CDMA2000 BTS
cdma2000 MS (R&S FSW-K83)	MC2K	CDMA2000 MS
1xEV-DO BTS (R&S FSW-K84)	BDO	1xEV-DO BTS
1xEV-DO MS (R&S FSW-K85)	MDO	1xEV-DO MS
WLAN (R&S FSW-K91)	WLAN	WLAN
LTE (R&S FSW-K10x)	LTE	LTE
Real-Time Spectrum (R&S FSW-B160R/-K160RE)	RTIM	Real-Time Spectrum
DOCSIS 3.1 (R&S FSW-K192)	DOCSis	DOCSIS 3.1
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

INSTrument:REName <ChannelName1>, <ChannelName2>

This command renames a measurement channel.

Parameters:

<ChannelName1> String containing the name of the channel you want to rename.

<ChannelName2> String containing the new channel name.
Note that you can not assign an existing channel name to a new channel; this will cause an error.

Example: `INST:REN 'IQAnalyzer2','IQAnalyzer3'`
Renames the channel with the name 'IQAnalyzer2' to 'IQAnalyzer3'.

Usage: Setting only

INSTrument[:SELect] <ChannelType>

This command selects a new measurement channel with the defined channel type.

Parameters:
<ChannelType> **LTE**
LTE measurement channel (R&S FSW-K10x)

Example: `INST LTE`
Selects the LTE application.

6.4 General Window Commands

The following commands are required to configure general window layout, independent of the application.

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:
<Format> **SPLit**
Displays the MultiView tab with an overview of all active channels
SINGle
Displays the measurement channel that was previously focused.
*RST: SING

Example: `DISP:FORM SPL`

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 107).

Parameters:

<Size>

LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALl
Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALl

Example: `DISP:WIND2:LARG`

6.5 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected measurement channel.

LAYout:ADD[:WINDow]? <WindowName>,<Direction>,<WindowType>

This command adds a window to the display in the active measurement channel.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Note: Use this command to select a result display instead of `CALCulate:FEED` (still supported for compatibilty reasons, but deprecated).

Parameters:

<WindowName>

String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction>	LEFT | RIGHt | ABOVe | BELow Direction the new window is added relative to the existing window.
<WindowType>	text value Type of result display (evaluation method) you want to add. See the table below for available parameter values.

Return values:

<NewWindowName>	When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:ADD? '1',LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

Manual operation:
See "Capture Buffer" on page 13
See "EVM vs Carrier" on page 14
See "EVM vs Symbol" on page 14
See "EVM vs Subframe" on page 15
See "Power Spectrum" on page 16
See "Inband Emission" on page 16
See "Spectrum Flatness" on page 17
See "Spectrum Flatness SRS" on page 17
See "Channel Group Delay" on page 18
See "Spectrum Flatness Difference" on page 18
See "Constellation Diagram" on page 19
See "CCDF" on page 19
See "Allocation Summary" on page 20
See "Bit Stream" on page 20
See "EVM vs Sym x Carr" on page 21
See "Power vs Symbol x Carrier" on page 21
See "Result Summary" on page 22
See "Marker Table" on page 24
See "Time Alignment Error" on page 25

Table 6-2: <WindowType> parameter values for LTE Uplink Measurement application

Parameter value	Window type
ASUM	Allocation Summary
BSTR	Bitstream
CBUF	Capture Buffer
CCDF	CCDF
CONS	Constellation Diagram
EVCA	EVM vs Carrier
EVSU	EVM vs Subframe

Parameter value	Window type
EVSY	EVM vs Symbol
EVSC	EVM vs Symbol X Carrier
FEVS	Frequency Error vs Symbol
GDEL	Group Delay
IE	Inband Emission
IEA	Inband Emission All
MTAB	Marker Table
PSPE	Power Spectrum
PVSC	Power vs Symbol X Carrier
RSUM	Result Summary
SFD	Spectrum Flatness Difference
SFL	Spectrum Flatness
SFSR	Spectrum Flatness SRS
TAL	Time Alignment Error

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows in the active measurement channel from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string

Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window in the active measurement channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Example: `LAY:WIND:IDEN? '2'`
Queries the index of the result display named '2'.
Response:
`2`

Usage: Query only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display in the active measurement channel.

Parameters:

<WindowName> String containing the name of the window.
In the default state, the name of the window is its index.

Example: `LAY:REM '2'`
Removes the result display in the window named '2'.

Usage: Event

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active measurement channel while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Parameters:

<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active measurement channel, use the `LAYout:CATalog[:WINDow]?` query.

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 103 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

LAYout:SPLitter <Index1>,<Index2>,<Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

Compared to the `DISPlay[:WINDow<n>]:SIZE` on page 102 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

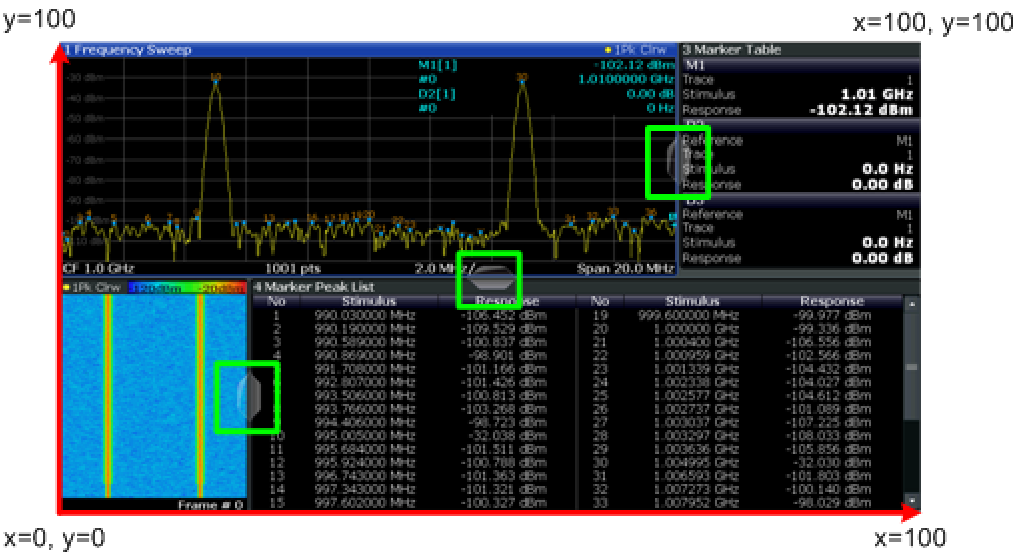


Fig. 6-1: SmartGrid coordinates for remote control of the splitters

Parameters:

<Index1>	The index of one window the splitter controls.
<Index2>	The index of a window on the other side of the splitter.
<Position>	New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu). The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See figure 6-1.) The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically. Range: 0 to 100

Example:

`LAY:SPL 1,3,50`

Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example:
`LAY:SPL 1,4,70`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.
`LAY:SPL 3,2,70`
`LAY:SPL 4,1,70`
`LAY:SPL 2,1,70`

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

This command adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added, as opposed to `LAYout:ADD[:WINDow]?`, for which the existing window is defined by a parameter.

To replace an existing window, use the `LAYout:WINDow<n>:REPLace` command.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

Parameters:

<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 103 for a list of available window types.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:
`LAY:WIND1:ADD? LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

This command queries the **name** of a particular display window (indicated by the <n> suffix) in the active measurement channel.

Note: to query the **index** of a particular window, use the `LAYout:IDENtify[:WINDow]?` command.

Return values:

<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Example: `LAY:WIND2:IDEN?`
Queries the name of the result display in window 2.
Response:
`'2'`

Usage: Query only

LAYout:WINDow<n>:REMove

This command removes the window specified by the suffix <n> from the display in the active measurement channel.

The result of this command is identical to the `LAYout:REMove[:WINDow]` command.

Example: `LAY:WIND2:REM`
Removes the result display in window 2.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>) in the active measurement channel.

The result of this command is identical to the `LAYout:REPLace[:WINDow]` command.

To add a new window, use the `LAYout:WINDow<n>:ADD?` command.

Parameters:

<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 103 for a list of available window types.

Example: `LAY:WIND2:REPL MTAB`
Replaces the result display in window 2 with a marker table.

6.6 Performing Measurements

6.6.1 Measurements

ABORt

This command aborts the measurement in the current measurement channel and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

For details see the "Remote Basics" chapter in the R&S FSW User Manual.

To abort a sequence of measurements by the Sequencer, use the `INITiate<n>:SEQuencer:ABORt` command.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel to the R&S FSW is blocked for further commands. In this case, you must interrupt processing on the remote channel first in order to abort the measurement.

To do so, send a "Device Clear" command from the control instrument to the R&S FSW on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`
- **GPIB**: `ibclr()`
- **RSIB**: `RSDLLibclr()`

Now you can send the `ABORt` command on the remote channel performing the measurement.

Example: `ABOR;:INIT:IMM`
Aborts the current measurement and immediately starts a new one.

Example: `ABOR;*WAI`
`INIT:IMM`
Aborts the current measurement and starts a new one once abortion has been completed.

Usage: Event
SCPI confirmed

INITiate<n>:CONTinuous <State>

This command controls the measurement mode for an individual measurement channel.

Note that in single measurement mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous measurement mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous measurement mode in remote control, as results like trace data or markers are only valid after a single measurement end synchronization.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

If the measurement mode is changed for a measurement channel while the Sequencer is active (see `INITiate<n>:SEQuencer:IMMediate` on page 112) the mode is only considered the next time the measurement in that channel is activated by the Sequencer.

Suffix:
<n> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

ON | 1
Continuous measurement

OFF | 0
Single measurement

*RST: 1

Example: `INIT:CONT OFF`
Switches the measurement mode to single measurement.
`INIT:CONT ON`
Switches the measurement mode to continuous measurement.

INITiate<n>[:IMMediate]

This command starts a (single) new measurement.

You can synchronize to the end of the measurement with *OPC, *OPC? or *WAI.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

Suffix:
<n> irrelevant

Usage: Event

[SENSe][:LTE]:OOPower:ATIMing

This command adjusts the timing for On/Off Power measurements.

Example: `OOP:ATIM`
Adjusts the On/Off Power timing.

Usage: Event

[SENSe]:SYNC[:STATe]?

This command queries the current synchronization state.

Return values:

<State> The string contains the following information.
A zero represents a failure and a one represents a successful synchronization.

Example: `SYNC:STAT?`
Would return, e.g. '1' for successful synchronization.

Usage: Query only

6.6.2 Measurement Sequences

INITiate<n>:SEQuencer:ABORt

This command stops the currently active sequence of measurements. The Sequencer itself is not deactivated, so you can start a new sequence immediately using `INITiate<n>:SEQuencer:IMMediate` on page 112.

To deactivate the Sequencer use `SYSTem:SEQuencer` on page 113.

Suffix:

<n> irrelevant

Usage: Event

INITiate<n>:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer.

Its effect is similar to the `INITiate<n>[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 113).

Suffix:

<n> irrelevant

Example: `SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

Usage: Event

INITiate<n>:SEQuencer:MODE <Mode>

This command selects the way the R&S FSW application performs measurements sequentially.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 113).

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSW User Manual.

Note: In order to synchronize to the end of a sequential measurement using *OPC, *OPC? or *WAI you must use `SINGle` Sequence mode.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

Suffix:

<n>	irrelevant

Parameters:

<Mode>

SINGle
Each measurement is performed once (regardless of the channel's sweep mode), considering each channels' sweep count, until all measurements in all active channels have been performed.

CONTinuous
The measurements in each active channel are performed one after the other, repeatedly (regardless of the channel's sweep mode), in the same order, until the Sequencer is stopped.

CDEFined
First, a single sequence is performed. Then, only those channels in continuous sweep mode (`INIT:CONT ON`) are repeated.

*RST: CONTinuous

Example:

`SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

SYSTem:SEQuencer <State>

This command turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error will occur.

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSW User Manual.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
The Sequencer is activated and a sequential measurement is started immediately.

OFF | 0
The Sequencer is deactivated. Any running sequential measurements are stopped. Further Sequencer commands (`INIT:SEQ...`) are not available.

*RST: 0

Example:
`SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single Sequencer mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.
`SYST:SEQ OFF`

6.7 Remote Commands to Read Trace Data

6.7.1 Using the TRACe[:DATA] Command

This chapter contains information on the TRACe:DATA command and a detailed description of the characteristics of that command.

The TRACe:DATA command queries the trace data or results of the currently active measurement or result display. The type, number and structure of the return values are specific for each result display. In case of results that have any kind of unit, the command returns the results in the unit you have currently set for that result display.

Note also that return values for results that are available for both downlink and uplink may be different.

For several result displays, the command also supports various SCPI parameters in combination with the query. If available, each SCPI parameter returns a different aspect of the results. If SCPI parameters are supported, you have to quote one in the query.

Example:

`TRAC2:DATA? TRACE1`

The format of the return values is either in ASCII or binary characters and depends on the format you have set with `FORMat[:DATA]`.

Following this detailed description, you will find a short summary of the most important functions of the command (`TRACe<n>[:DATA]?`).

Selecting a measurement window

Compared to the LTE application on the R&S FSQ or R&S FSV, you have to select the measurement window directly with the suffix <n> at `TRACe`. The range of <n> depends on the number of active measurement windows.

On an R&S FSQ or R&S FSV, the suffix <n> was not supported. On these instruments, you had to select the measurement window with `DISPlay:WINDow<n>:SELect` first.

6.7.1.1 Adjacent Channel Leakage Ratio

For the ACLR result display, the number and type of returns values depend on the parameter.

- TRACE1
  Returns one value for each trace point.

6.7.1.2 Allocation Summary

For the Allocation Summary, the command returns seven values for each line of the table.

```
<subframe>, <allocation ID>, <number of RB>, <offset RB>,
<modulation>, <absolute power>, <EVM>, ...
```

The unit for `<absolute power>` is always dBm. The unit for `<EVM>` depends on `UNIT:EVM`. All other values have no unit.

The `<allocation ID>` and `<modulation>` are encoded. For the code assignment see chapter 6.7.1.20, "Return Value Codes", on page 122.

Note that the data format of the return values is always ASCII.

Example:

Allocation Summary

Sub-frame	Alloc. ID	Number of RB	Offset RB	Modulation	Power/ dBm	EVM/%
0	PUSCH	10	2	QPSK	-84,743	0,002
	DMRS PUSCH			CAZAC	-84,743	0,002
	SRS			CAZAC	-80,940	0,003

`TRAC:DATA? TRACE1` would return:

```
0, -40, 10, 2, 2, -84.7431947342849, 2.68723483754626E-06,
0, -41, 0, 0, 6, -84.7431432845264, 2.37549449584568E-06,
0, -42, 0, 0, 6, -80.9404231343884, 3.97834623871343E-06,
...
```

6.7.1.3 Bit Stream

For the Bit Stream result display, the command returns five values and the bitstream for each line of the table.

`<subframe>, <modulation>, <# of symbols/bits>, <hexadecimal/binary numbers>,...`

All values have no unit. The format of the bitstream depends on Bit Stream Format.

The `<modulation>` is encoded. For the code assignment see chapter 6.7.1.20, "Return Value Codes", on page 122.

For symbols or bits that are not transmitted, the command returns

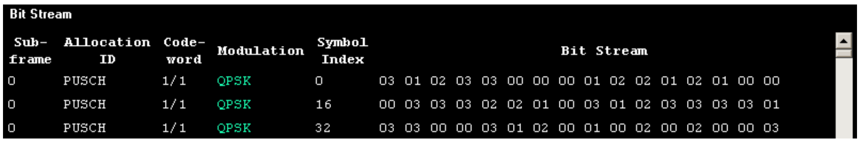
- "FFF" if the bit stream format is "Symbols"
- "9" if the bit stream format is "Bits".

For symbols or bits that could not be decoded because the number of layer exceeds the number of receive antennas, the command returns

- "FFE" if the bit stream format is "Symbols"
- "8" if the bit stream format is "Bits".

Note that the data format of the return values is always ASCII.

Example:


Bit Stream

Sub-frame	Allocation ID	Code-word	Modulation	Symbol Index	Bit Stream
0	PUSCH	1/1	QPSK	0	03 01 02 03 03 00 00 00 01 02 02 01 02 01 00 00
0	PUSCH	1/1	QPSK	16	00 03 03 03 02 02 01 00 03 01 02 03 03 03 03 01
0	PUSCH	1/1	QPSK	32	03 03 00 00 03 01 02 00 01 00 02 00 02 00 00 03

`TRAC:DATA? TRACE1` would return:

```
0, -40, 0, 2, 0, 03, 01, 02, 03, 03, 00, 00, 00, 01, 02, 02, ...
<continues like this until the next data block starts or the end of data is
reached>
0, -40, 0, 2, 32, 03, 03, 00, 00, 03, 01, 02, 00, 01, 00, ...
```

6.7.1.4 Capture Buffer

For the Capture Buffer result display, the command returns one value for each I/Q sample in the capture buffer.

`<absolute power>, ...`

The unit is always dBm.

The following parameters are supported.

- TRACE1

6.7.1.5 CCDF

For the CCDF result display, the type of return values depends on the parameter.

- TRACE1
  Returns the probability values (y-axis).
  `<# of values>, <probability>, ...`
  The unit is always %.
  The first value that is returned is the number of the following values.
- TRACE2
  Returns the corresponding power levels (x-axis).
  `<# of values>, <relative power>, ...`
  The unit is always dB.
  The first value that is returned is the number of the following values.

6.7.1.6 Channel and Spectrum Flatness

For the Channel Flatness result display, the command returns one value for each trace point.

`<relative power>, ...`

The unit is always dB.

The following parameters are supported.

- TRACE1

Returns the average power over all subframes.

- TRACE2
Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.7.1.7 Channel and Spectrum Flatness Difference

For the Channel Flatness Difference result display, the command returns one value for each trace point.

```
<relative power>, ...
```

The unit is always dB. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
Returns the average power over all subframes.
- TRACE2
Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.7.1.8 Channel Flatness SRS

For the Channel Flatness SRS result display, the command returns one value for each trace point.

```
<relative power>, ...
```

The unit is always dB.

The following parameters are supported.

- TRACE1
Returns the average power over all subframes.
- TRACE2
Returns the minimum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
Returns the maximum power found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.7.1.9 Channel Group Delay

For the Channel Group Delay result display, the command returns one value for each trace point.

`<group delay>, ...`

The unit is always ns. The number of values depends on the selected LTE bandwidth.

The following parameters are supported.

- TRACE1
  Returns the average group delay over all subframes.
- TRACE2
  Returns the minimum group delay found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum group delay found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.7.1.10 Constellation Diagram

For the Constellation Diagram, the command returns two values for each constellation point.

<I[SF0][Sym0][Carrier1]>, <Q[SF0][Sym0][Carrier1]>, ..., <I[SF0][Sym0][Carrier(n)]>, <Q[SF0][Sym0][Carrier(n)]>,

<I[SF0][Sym1][Carrier1]>, <Q[SF0][Sym1][Carrier1]>, ..., <I[SF0][Sym1][Carrier(n)]>, <Q[SF0][Sym1][Carrier(n)]>,

<I[SF0][Sym(n)][Carrier1]>, <Q[SF0][Sym(n)][Carrier1]>, ..., <I[SF0][Sym(n)][Carrier(n)]>, <Q[SF0][Sym(n)][Carrier(n)]>,

<I[SF1][Sym0][Carrier1]>, <Q[SF1][Sym0][Carrier1]>, ..., <I[SF1][Sym0][Carrier(n)]>, <Q[SF1][Sym0][Carrier(n)]>,

<I[SF1][Sym1][Carrier1]>, <Q[SF1][Sym1][Carrier1]>, ..., <I[SF1][Sym1][Carrier(n)]>, <Q[SF1][Sym1][Carrier(n)]>,

<I[SF(n)][Sym(n)][Carrier1]>, <Q[SF(n)][Sym(n)][Carrier1]>, ..., <I[SF(n)][Sym(n)][Carrier(n)]>, <Q[SF(n)][Sym(n)][Carrier(n)]>

With SF = subframe and Sym = symbol of that subframe.

The I and Q values have no unit.

The number of return values depends on the constellation selection. By default, it returns all resource elements including the DC carrier.

The following parameters are supported.

- TRACE1
  Returns all constellation points included in the selection.
- TRACE2
  Returns the constellation points of the reference symbols included in the selection.
- TRACE3
  Returns the constellation points of the SRS included in the selection.

6.7.1.11 EVM vs Carrier

For the EVM vs Carrier result display, the command returns one value for each subcarrier that has been analyzed.

`<EVM>, ...`

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1
  Returns the average EVM over all subframes
- TRACE2
  Returns the minimum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.
- TRACE3
  Returns the maximum EVM found over all subframes. If you are analyzing a particular subframe, it returns nothing.

6.7.1.12 EVM vs Subframe

For the EVM vs Subframe result display, the command returns one value for each subframe that has been analyzed.

`<EVM>, ...`

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

6.7.1.13 EVM vs Symbol

For the EVM vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

`<EVM>, ...`

For measurements on a single subframe, the command returns the symbols of that subframe only.

The unit depends on `UNIT:EVM`.

The following parameters are supported.

- TRACE1

6.7.1.14 EVM vs Symbol x Carrier

For the EVM vs Symbol x Carrier, the command returns one value for each resource element.

`<EVM[Symbol(0),Carrier(1)]>, ..., <EVM[Symbol(0),Carrier(n)]>,`

`<EVM[Symbol(1),Carrier(1)]>, ..., <EVM[Symbol(1),Carrier(n)]>,`

`...`

`<EVM[Symbol(n),Carrier(1)]>, ..., <EVM[Symbol(n),Carrier(n)]>,`

The unit depends on `UNIT:EVM`.

Resource elements that are unused return `NAN`.

The following parameters are supported.

- TRACE1

6.7.1.15 Frequency Error vs Symbol

For the Frequency Error vs Symbol result display, the command returns one value for each OFDM symbol that has been analyzed.

`<frequency error>,...`

The unit is always Hz.

The following parameters are supported.

- TRACE1

6.7.1.16 Inband Emission

For the Inband Emission result display, the number and type of returns values depend on the parameter.

- TRACE1
  Returns the relative resource block indices (x-axis values).
  `<RB index>, ...`
  The resource block index has no unit.
- TRACE2
  Returns one value for each resource block index.
  `<relative power>, ...`
  The unit of the relative inband emission is dB.
- TRACE3
  Returns the data points of the upper limit line.
  `<limit>, ...`
  The unit is always dB.

Note that you have to select a particular subframe to get results.

6.7.1.17 Power Spectrum

For the Power Spectrum result display, the command returns one value for each trace point.

`<power>,...`

The unit is always dBm/Hz.

The following parameters are supported.

- TRACE1

6.7.1.18 Power vs Symbol x Carrier

For the Power vs Symbol x Carrier, the command returns one value for each resource element.

`<P[Symbol(0),Carrier(1)]>, ..., <P[Symbol(0),Carrier(n)]>,`

`<P[Symbol(1),Carrier(1)]>, ..., <P[Symbol(1),Carrier(n)]>,`

`...`

`<P[Symbol(n),Carrier(1)]>, ..., <P[Symbol(n),Carrier(n)]>,`

with P = Power of a resource element.

The unit is always dBm.

Resource elements that are unused return `NAN`.

The following parameters are supported.

- TRACE1

6.7.1.19 Spectrum Emission Mask

For the SEM measurement, the number and type of returns values depend on the parameter.

- TRACE1
  Returns one value for each trace point.
  `<absolute power>, ...`
  The unit is always dBm.
- LIST
  Returns the contents of the SEM table. For every frequency in the spectrum emission mask, it returns 11 values.
  `<index>, <start frequency in Hz>, <stop frequency in Hz>, <RBW in Hz>, <limit fail frequency in Hz>, <absolute power in dBm>, <relative power in dBc>, <limit distance in dB>, <limit check result>, <reserved>, <reserved>...`
  The `<limit check result>` is either a 0 (for PASS) or a 1 (for FAIL).

6.7.1.20 Return Value Codes

This chapter contains a list for encoded return values.

<allocation ID>

Represents the allocation ID. The value is a number in the range {1...-70}.

- **1** = Reference symbol
- **0** = Data symbol

- **-1** = Invalid
- **-40** = PUSCH
- **-41** = DMRS PUSCH
- **-42** = SRS PUSCH
- **-50** = PUCCH
- **-51** = DMRS PUCCH
- **-70** = PRACH

<channel type>

- **0** = TX channel
- **1** = adjacent channel
- **2** = alternate channel

<codeword>

Represents the codeword of an allocation. The range is {0...6}.

- **0** = 1/1
- **1** = 1/2
- **2** = 2/2
- **3** = 1/4
- **4** = 2/4
- **5** = 3/4
- **6** = 4/4

<modulation>

Represents the modulation scheme. The range is {0...14}.

- **0** = unrecognized
- **1** = RBPSK
- **2** = QPSK
- **3** = 16QAM
- **4** = 64QAM
- **5** = 8PSK
- **6** = PSK
- **7** = mixed modulation
- **8** = BPSK

<number of symbols or bits>

In hexadecimal mode, this represents the number of symbols to be transmitted. In binary mode, it represents the number of bits to be transmitted.

TRACe<n>[:DATA]? <Result>

This command returns the trace data for the current measurement or result display.

For more information see chapter 6.7.1, "Using the TRACe[:DATA] Command", on page 114.

Query parameters:

<TraceNumber> **TRACE1 | TRACE2 | TRACE3**

LIST

Example: `TRAC2? TRACE1`

Queries results of the second measurement window. The type of data that is returned by the parameter (`TRACE1`) depends on the result display shown in measurement window 2.

Usage: Query only

6.7.2 Remote Commands to Read Measurement Results

CALCulate<n>:MARKer<m>:FUNCtion:POWer:RESult[:CURRent]? <ResultType>

This command queries the current results of the ACLR measurement or the total signal power level of the SEM measurement.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps.

Suffix:

<m> 1

Query parameters:

<ResultType> **CPOW**

This parameter queries the channel power of the reference range.

MCAC

Queries the channel powers of the ACLR, MC ACLR and Cumulative ACLR measurements as shown in the ACLR table.
Where available, this parameter also queries the power of the adjacent channels (for example in the ACLR measurement).

GACLr

Queries the ACLR values for each gap channel in the MC ACLR measurement.

Return values:

<Result> **Results for the Spectrum Emission Mask measurement:**
Power level in dBm.

Results for the ACLR measurements:
Relative power levels of the ACLR channels. The number of return values depends on the number of transmission and adjacent channels. The order of return values is:
• <TXChannelPower> is the power of the transmission channel in dBm
• <LowerAdjChannelPower> is the relative power of the lower adjacent channel in dB
• <UpperAdjChannelPower> is the relative power of the upper adjacent channel in dB
• <1stLowerAltChannelPower> is the relative power of the first lower alternate channel in dB
• <1stUpperAltChannelPower> is the relative power of the first lower alternate channel in dB
(...)
• <nthLowerAltChannelPower> is the relative power of a subsequent lower alternate channel in dB
• <nthUpperAltChannelPower> is the relative power of a subsequent lower alternate channel in dB

Example: `CALC1:MARK:FUNC:POW:RES? MCAC`
Returns the current ACLR measurement results.

Usage: Query only

Manual operation: See "ACLR" on page 27
See "Multi Carrier ACLR" on page 29

FORMat[:DATA] [<Format>]

This command specifies the data format for the data transmission between the LTE measurement application and the remote client. Supported formats are ASCII or REAL32.

Parameters:

<Format> ASCii | REAL

*RST: ASCii

Example: `FORM REAL`
The software will send binary data in Real32 data format.

6.8 Remote Commands to Read Numeric Results

6.8.1 Frame Results

FETCh:SUMMary:EVM:SDQP[:AVERage]?

This command queries the EVM of all DMRS resource elements with QPSK modulation of the PUSCH.

Return values:

<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:SDQP?`

Returns the EVM of all DMRS resource elements with QPSK modulation.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh:SUMMary:EVM:SDSF[:AVERage]?

This command queries the EVM of all DMRS resource elements with 64QAM modulation of the PUSCH.

Return values:

<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:SDSF?`

Returns the maximum EVM of all DMRS resource elements with 64QAM modulation.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh:SUMMary:EVM:SDST[:AVERage]?

This command queries the EVM of all DMRS resource elements with 16QAM modulation of the PUSCH.

Return values:

<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:SDST?`

Returns the EVM of all DMRS resource elements with 16QAM modulation.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh:SUMMary:EVM:UCCD[:AVERage]?

This command queries the EVM of all DMRS resource elements of the PUCCH as shown in the result summary.

Return values:

<EVM> EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:UCCD?`

Returns the average EVM of all DMRS resource elements.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh:SUMMary:EVM:UCCH[:AVERage]?

This command queries the EVM of all resource elements of the PUCCH as shown in the result summary.

Return values:

<EVM> EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:UCCH?`

Returns the average EVM of all resource elements.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh:SUMMary:EVM:UPRA[:AVERage]?

This command queries the EVM of all resource elements of the PRACH as shown in the result summary.

Return values:

<EVM> EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:UPRA?`
Returns the average EVM of all resource elements.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh:SUMMary:EVM:USQP[:AVERage]?

This query returns the EVM for all QPSK-modulated resource elements of the PUSCH.

Return values:

<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:USQP?`
Queries the PUSCH QPSK EVM.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh:SUMMary:EVM:USSF[:AVERage]?

This command queries the EVM for all 64QAM-modulated resource elements of the PUSCH.

Return values:

<EVM> <numeric value>

EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:USSF?`
Queries the PUSCH 64QAM EVM.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh:SUMMary:EVM:USST[:AVERage]?

This query returns the the EVM for all 16QAM-modulated resource elements of the PUSCH.

Return values:

<EVM> EVM in % or dB, depending on the unit you have set.

Example: `FETC:SUMM:EVM:USST?`
Queries the PUSCH 16QAM EVM.

Usage: Query only

Manual operation: See "Result Summary" on page 22

6.8.2 Result for Selection

FETCh[:CC<cci>]:SUMMary:CRESt[:AVERage]?

This command queries the average crest factor as shown in the result summary.

Suffix:
<cci> 1..2

Return values:
<CrestFactor> <numeric value>
Crest Factor in dB.

Example: `FETC:SUMM:CRES?`
Returns the current crest factor in dB.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh[:CC<cci>]:SUMMary:EVM[:ALL]:MAXimum?
FETCh[:CC<cci>]:SUMMary:EVM[:ALL]:MINimum?
FETCh[:CC<cci>]:SUMMary:EVM[:ALL][:AVERage]?

This command queries the EVM of all resource elements.

Suffix:

<cci> 1..2

Return values:

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM?`
Returns the mean value.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh[:CC<cci>]:SUMMary:EVM:PCHannel:MAXimum?
FETCh[:CC<cci>]:SUMMary:EVM:PCHannel:MINimum?
FETCh[:CC<cci>]:SUMMary:EVM:PCHannel[:AVERage]?

This command queries the EVM of all physical channel resource elements.

Suffix:

<cci> 1..2

Return values:

<EVM>

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh[:CC<cci>]:SUMMary:EVM:PSIGnal:MAXimum?
FETCh[:CC<cci>]:SUMMary:EVM:PSIGnal:MINimum?
FETCh[:CC<cci>]:SUMMary:EVM:PSIGnal[:AVERage]?

This command queries the EVM of all physical signal resource elements.

Suffix:

<cci> 1..2

Return values:

<EVM> <numeric value>

Minimum, maximum or average EVM, depending on the last command syntax element.
The unit is % or dB, depending on your selection.

Example: `FETC:SUMM:EVM:PSIG?`
Returns the mean value.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh[:CC<cci>]:SUMMary:FERRor:MAXimum?
FETCh[:CC<cci>]:SUMMary:FERRor:MINimum?
FETCh[:CC<cci>]:SUMMary:FERRor[:AVERage]?

This command queries the frequency error.

Suffix:
<cci> 1..2

Return values:
<FreqError> <numeric value>

Minimum, maximum or average frequency error, depending on the last command syntax element.

Default unit: Hz

Example: `FETC:SUMM:FERR?`
Returns the average frequency error in Hz.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh[:CC<cci>]:SUMMary:GIMBalance:MAXimum?
FETCh[:CC<cci>]:SUMMary:GIMBalance:MINimum?
FETCh[:CC<cci>]:SUMMary:GIMBalance[:AVERage]?

This command queries the I/Q gain imbalance.

Suffix:
<cci> 1..2

Return values:
<GainImbalance> <numeric value>

Minimum, maximum or average I/Q imbalance, depending on the last command syntax element.

Default unit: dB

Example: `FETC:SUMM:GIMB?`
Returns the current gain imbalance in dB.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh[:CC<cci>]:SUMMary:IQOFfset:MAXimum?
FETCh[:CC<cci>]:SUMMary:IQOFfset:MINimum?
FETCh[:CC<cci>]:SUMMary:IQOFfset[:AVERage]?

This command queries the I/Q offset.

Suffix:
<cci> 1..2

Return values:
<IQOffset> <numeric value>
Minimum, maximum or average I/Q offset, depending on the last command syntax element.
Default unit: dB

Example: `FETC:SUMM:IQOF?`
Returns the current IQ-offset in dB

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh[:CC<cci>]:SUMMary:POWer:MAXimum?
FETCh[:CC<cci>]:SUMMary:POWer:MINimum?
FETCh[:CC<cci>]:SUMMary:POWer[:AVERage]?

This command queries the total power.

Suffix:
<cci> 1..2

Return values:
<Power> <numeric value>
Minimum, maximum or average power, depending on the last command syntax element.
Default unit: dBm

Example: `FETC:SUMM:POW?`
Returns the total power in dBm

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh[:CC<cci>]:SUMMary:QUADerror:MAXimum?
FETCh[:CC<cci>]:SUMMary:QUADerror:MINimum?
FETCh[:CC<cci>]:SUMMary:QUADerror[:AVERage]?

This command queries the quadrature error.

Suffix:
<cci> 1..2

Return values:
<QuadError> <numeric value>
Minimum, maximum or average quadrature error, depending on the last command syntax element.
Default unit: deg

Example: `FETC:SUMM:QUAD?`
Returns the current mean quadrature error in degrees.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh[:CC<cci>]:SUMMary:SERRor:MAXimum?
FETCh[:CC<cci>]:SUMMary:SERRor:MINimum?
FETCh[:CC<cci>]:SUMMary:SERRor[:AVERage]?

This command queries the sampling error.

Suffix:
<cci> 1..2

Return values:
<SamplingError> <numeric value>

Minimum, maximum or average sampling error, depending on the last command syntax element.

Default unit: ppm

Example: `FETC:SUMM:SERR?`
Returns the current mean sampling error in ppm.

Usage: Query only

Manual operation: See "Result Summary" on page 22

FETCh:SUMMary:TFRame?

This command queries the (sub)frame start offset as shown in the Capture Buffer result display.

Note that you have to select a particular subframe; otherwise the command returns an error.

Return values:
<Offset> Time difference between the (sub)frame start and capture buffer start.

Default unit: s

Example: `FETC:SUMM:TFR?`
Returns the (sub)frame start offset.

Usage: Query only

Manual operation: See "Capture Buffer" on page 13

6.8.3 Time Alignment Error

FETCh:FEPPm[:CC<cci>]:MAXimum?
FETCh:FEPPm[:CC<cci>]:MINimum?
FETCh:FEPPm[:CC<cci>][:AVERage]

This command queries the Carrier Frequency Error.

Return values:

<FrequencyError> Average, minimum or maxmum frequency error, depending on the command syntax.
Default unit: ppm

Example: `FETC:FERR:MAX?`
Queries the maximum frequency error.

Manual operation: See "Carrier Frequency Error" on page 26

FETCh:FERRor[:CC<cci>]:MAXimum?
FETCh:FERRor[:CC<cci>]:MINimum?
FETCh:FERRor[:CC<cci>][:AVERage]?

This command queries the Carrier Frequency Error.

Return values:

<FrequencyError> Average, minimum or maxmum frequency error, depending on the command syntax.
Default unit: Hz

Example: `FETC:FERR?`
Queries the average frequency error.

Usage: Query only

Manual operation: See "Carrier Frequency Error" on page 26

FETCh:TAERror[:CC<cci>]:ANTenna<antenna>:MAXimum
FETCh:TAERror[:CC<cci>]:ANTenna<antenna>:MINimum
FETCh:TAERror[:CC<cci>]:ANTenna<antenna>[:AVERage]?

This command queries the time alignment error.

Return values:

<Time Alignment Error>	Minimum, maximum or average time alignment error, depending on the last command syntax element. Default unit: s

Example: `FETC:TAER:ANT2?`
Returns the average time alignment error between the reference antenna and antenna 2 in s.

Usage: Query only

Manual operation: See "Time Alignment Error" on page 25

6.8.4 Marker Table

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Example: `CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

CALCulate<n>:DELTamarker<m>:Y?

This command queries the relative position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

See also `INITiate<n>:CONTinuous` on page 110.

The unit depends on the application of the command.

Return values:

<Position>	Position of the delta marker in relation to the reference marker or the fixed reference.

Example: `INIT:CONT OFF`
Switches to single sweep mode.
`INIT;*WAI`
Starts a sweep and waits for its end.
`CALC:DELT2 ON`
Switches on delta marker 2.
`CALC:DELT2:Y?`
Outputs measurement value of delta marker 2.

Usage: Query only

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Parameters:
<Position> Numeric value that defines the marker position on the x-axis.
Range: The range depends on the current x-axis range.

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "Marker Table" on page 24

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single measurement mode.

See also `INITiate<n>:CONTinuous` on page 110.

Return values:
<Result> Result at the marker position.

Example: `INIT:CONT OFF`
Switches to single measurement mode.
`CALC:MARK2 ON`
Switches marker 2.
`INIT;*WAI`
Starts a measurement and waits for the end.
`CALC:MARK2:Y?`
Outputs the measured value of marker 2.

Usage: Query only

Manual operation: See "Marker Table" on page 24

6.9 Remote Commands to Read Limit Check Results

6.9.1 Checking Limits for Graphical Result Displays

CALCulate<n>:LIMit<k>:ACPower:ACHannel:RESult? <Result>

This command queries the limit check results for the adjacent channels during ACLR measurements.

Return values:

<LimitCheck> Returns two values, one for the upper and one for the lower adjacent channel.

PASSED
Limit check has passed.

FAILED
Limit check has failed.

Example: `CALC:LIM:ACP:ACH:RES? ALL`
Queries the results of the adjacent channel limit check.

Usage: Query only

Manual operation: See "Multi Carrier ACLR" on page 29

CALCulate<n>:LIMit<k>:ACPower:ALTernate:RESult? <Result>

This command queries the limit check results for the alternate channels during ACLR measurements.

Return values:

<LimitCheck> Returns two values, one for the upper and one for the lower alternate channel.

PASSED
Limit check has passed.

FAILED
Limit check has failed.

Example: `CALC:LIM:ACP:ALT:RES? ALL`
Queries the results of the alternate channel limit check.

Usage: Query only

Manual operation: See "Multi Carrier ACLR" on page 29

CALCulate<n>:LIMit<k>:FAIL?

This command queries the limit check results for all measurements that feature a limit check.

Return values:

<LimitCheck> Returns two values, one for the upper and one for the lower adjacent or alternate channel.

0
Limit check has passed.

1
Limit check has failed.

Example: `CALC:LIM:FAIL?`
Queries the limit check of the active result display.

Usage: Query only

6.9.2 Checking Limits for Numerical Result Display

CALCulate<n>:LIMit<k>:SUMMary:EVM[:ALL]:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM[:ALL][:AVERage]:RESult?

This command queries the results of the EVM limit check of all resource elements.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:PCHannel:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:PCHannel[:AVERage]:RESult?

This command queries the results of the EVM limit check of all physical channel resource elements.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:PCH:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:PSIGnal:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:EVM:PSIGnal[:AVERage]:RESult?

This command queries the results of the EVM limit check of all physical signal resource elements.

Return values:
<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:PSIG:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:SDQP[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PUSCH DMRS resource elements with a QPSK modulation.

Return values:
<LimitCheck>

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:SDQP:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:SDSF[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PUSCH DMRS resource elements with a 64QAM modulation.

Return values:
<LimitCheck>

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:SDSF:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:SDST[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PUSCH DMRS resource elements with a 16QAM modulation.

Return values:

<LimitCheck>

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:SDST:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:UCCD[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PUCCH DMRS resource elements.

Return values:

<LimitCheck>

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:UCCD:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:UCCH[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PUCCH resource elements.

Return values:

<LimitCheck>

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:UCCH:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:UPRA[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PRACH resource elements.

Return values:

<LimitCheck>

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:UPRA:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:USQP[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PUSCH resource elements with a QPSK modulation

Return values:

<LimitCheck>

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:USQP:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:USSF[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PUSCH resource elements with a 64QAM modulation.

Return values:

<LimitCheck>

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:USSF:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:EVM:USST[:AVERage]:RESult?

This command queries the results of the EVM limit check of all PUSCH resource elements with a 16QAM modulation.

Return values:

<LimitCheck>

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:EVM:USST:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:FERRor:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:FERRor[:AVERage]:RESult?

This command queries the result of the frequency error limit check.

Return values:

<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:SERR:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:GIMBalance:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:GIMBalance[:AVERage]:RESult?

This command queries the result of the gain imbalance limit check.

Return values:
<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:GIMB:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:IQOFfset:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:IQOFfset[:AVERage]:RESult?

This command queries the result of the I/Q offset limit check.

Return values:
<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:IQOF:MAX:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:QUADerror:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:QUADerror[:AVERage]:RESult?

This command queries the result of the quadrature error limit check.

Return values:
<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:QUAD:RES?`
Queries the limit check.

Usage: Query only

CALCulate<n>:LIMit<k>:SUMMary:SERRor:MAXimum:RESult
CALCulate<n>:LIMit<k>:SUMMary:SERRor[:AVERage]:RESult?

This command queries the results of the sampling error limit check.

Return values:
<LimitCheck> The type of limit (average or maximum) that is queried depends on the last syntax element.

FAILED
Limit check has failed.

PASSED
Limit check has passed.

NOTEVALUATED
Limits have not been evaluated.

Example: `CALC:LIM:SUMM:SERR:RES?`
Queries the limit check.

Usage: Query only

6.10 Remote Commands to Configure the Application

6.10.1 General Configuration

The following remote control command control general configration of the application.

The remote control commands to select the result displays for I/Q measurements are described in chapter 6.5, "Working with Windows in the Display", on page 103.

CONFigure[:LTE]:MEASurement <Measurement>

This command selects the measurement.

Parameters:

<Measurement>	**ACLR** Selects the Adjacent Channel Leakage Ratio measurement. **ESPectrum** Selects the Spectrum Emission Mask measurement. **EVM** Selects I/Q measurements with the "EVM" display configuration. **MCACl r** Selects Multi-Carrier ACLR measurement. **MCESpectrum** Selects Multi-Carrier SEM measurement. **TAERor** Selects the Time Alignment Error measurement. **TPOO** Selects the Transmit On/Off Power measurement.
Example:	`CONF:MEAS ACLR` Selects the ACLR measurement.
Manual operation:	See "ACLR" on page 27 See "Spectrum Mask" on page 28 See "Multi Carrier ACLR" on page 29 See "Select Measurement" on page 43

MMEMory:LOAD:IQ:STATe <Path>

This command restores I/Q data from a file.

Setting parameters:

<Path>	String containing the path and name of the source file.
Example:	`MMEM:LOAD:IQ:STAT 'C:\R_S\Instr\user\data.iq.tar'` Loads I/Q data from the specified file.
Usage:	Setting only

SYSTem:PRESet:CHANnel[:EXECute]

This command restores the default application settings in the current channel.

Use `INST:SEL` to select the channel.

Example:	`INST 'Spectrum2'`
	Selects the channel for "Spectrum2".
	`SYST:PRES:CHAN:EXEC`
	Restores the factory default settings to the "Spectrum2" channel.

Usage:	Event
Manual operation:	See "Preset Channel" on page 43

6.10.2 Configuring I/Q Measurements

6.10.2.1 Signal Description

Signal Characteristics

CONFigure[:LTE]:DUPLexing <Duplexing>

This command selects the duplexing mode.

Parameters:

<Duplexing>

TDD
Time division duplex

FDD
Frequency division duplex

*RST: FDD

Example: `CONF:DUPL TDD`
Activates time division duplex.

Manual operation: See "Selecting the LTE Mode" on page 45

CONFigure[:LTE]:LDIRection <Direction>

This command selects the link direction

Parameters:

<Direction>

DL
Downlink

UL
Uplink

Example: `CONF:LDIR DL`
EUTRA/LTE option is configured to analyze downlink signals.

Manual operation: See "Selecting the LTE Mode" on page 45

CONFigure[:LTE]:UL[:CC<cci>]:BW <Bandwidth>

This command selects the channel bandwidth.

Parameters:

<Bandwidth> BW1_40 | BW3_00 | BW5_00 | BW10_00 | BW15_00 | BW20_00

Example: Single carrier measurement:
`CONF:UL:BW BW1_40`
Defines a channel bandwidth of 1.4 MHz.

Example: Aggregated carrier measurement:
`CONF:UL:CC1:BW BW5_00`
Defines a channel bandwidth of 5 MHz for the first carrier.

Manual operation: See "Channel Bandwidth / Number of Resource Blocks" on page 46
See "Remote commands to configure carrier aggregation" on page 83

CONFigure[:LTE]:UL[:CC<cci>]:CYCPrefix <PrefixLength>

This command selects the cyclic prefix.

Parameters:

<PrefixLength>

NORM
Normal cyclic prefix length

EXT
Extended cyclic prefix length

AUTO
Automatic cyclic prefix length detection

*RST: AUTO

Example: Single carrier measurements:
`CONF:UL:CYCP EXT`
Selects an extended cyclic prefix.

Example: Aggregated carrier measurements:
`CONF:UL:CC1:CYCP EXT`
Selects an extended cyclic prefix for the first carrier.

Manual operation: See "Cyclic Prefix" on page 46

CONFigure[:LTE]:UL[:CC<cci>]:PLC:CID <CellId>

This command defines the cell ID.

Parameters:

<CellId>

AUTO
Automatically defines the cell ID.

<numeric value>
Number of the cell ID.

Range: 0 to 503

Example: `CONF:UL:PLC:CID AUTO`
Automatically detects the cell ID.

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 48

CONFigure[:LTE]:UL[:CC<cci>]:PLC:CIDGroup <GroupNumber>

This command selects the cell identity group for uplink signals.

Parameters:

<GroupNumber>

Range: 1 to 167
*RST: 0

Example: `CONF:UL:PLCI:CIDG 12`
Selects cell identity group 12.

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 48

CONFigure[:LTE]:UL[:CC<cci>]:PLC:PLID <Identity>

This command selects the physical layer identity for uplink signals.

Parameters:

<Identity>

0...2
Manual selection

*RST: AUTO

Example: `CONF:DL:PLC:PLID 2`
Sets the physical layer identity to 2.

Manual operation: See "Configuring the Physical Layer Cell Identity" on page 48

CONFigure[:LTE]:UL[:CC<cci>]:TDD:SPSC <Configuration>

This command selects the special TDD subframe configuration.

Parameters:
<Configuration> <numeric value>

Example: Single carrier measurements:
`CONF:UL:TDD:SPSC 2`
Selects special subframe configuration 2.

Example: Carrier aggregation measurements:
`CONF:UL:CC1:TDD:SPSC 2`
Selects special subframe configuration 2 for the first carrier.

Manual operation: See "Conf. of Special Subframe" on page 47

CONFigure[:LTE]:UL[:CC<cci>]:TDD:UDConf <Configuration>

This command selects the subframe configuration for TDD signals.

Parameters:
<Configuration> Range: 0 to 6
*RST: 0

Example: Single carrier measurements:
`CONF:UL:TDD:UDC 4`
Selects allocation configuration number 4.

Example: Carrier aggregation measurements:
`CONF:UL:CC1:TDD:UDC 4`
Selects allocation configuration number 4 for the first carrier.

Manual operation: See "TDD UL/DL Allocations" on page 47

MMEMory:LOAD:DEModsetting <Path>

This command restores previously saved demodulation settings.

The file must be of type "*.allocation" and depends on the link direction that was currently selected when the file was saved. You can load only files with correct link directions.

Setting parameters:
<Path> String containing the path and name of the file.

Example: `MMEM:LOAD:DEM 'D:\USER\Settingsfile.allocation'`

Usage: Setting only

MMEMory:LOAD:TMOD:DL <TestModel>

This command loads an EUTRA test model (E-TM).

The test models are in accordance with 3GPP TS 36.141.

Setting parameters:

<TestModel>

'E-TM1_1__20MHz'
EUTRA Test Model 1.1 (E-TM1.1)

'E-TM1_2__20MHz'
EUTRA Test Model 1.2 (E-TM1.2)

'E-TM2__20MHz'
EUTRA Test Model 2 (E-TM2)

'E-TM3_1__20MHz'
EUTRA Test Model 3.1 (E-TM3.1)

'E-TM3_2__20MHz'
EUTRA Test Model 3.2 (E-TM3.2)

'E-TM3_3__20MHz'
EUTRA Test Model 3.3 (E-TM3.3)
To select a test model for a different bandwidth, replace "20MHz" with either "1_4MHz", "3MHz", "5MHz", "10MHz" or "15MHz".

Example: `MMEM:LOAD:TMOD:DL 'E-TM2__10MHz'`
Selects test model 2 for a 10 MHz bandwidth.

Usage: Setting only

[SENSe][:LTE]:SFLatness:ECONditions <State>

This command turns extreme conditions for spectrum flatness measurements on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `SFL:ECON ON`
Turns extreme conditions on.

Manual operation: See "Extreme Conditions" on page 48

[SENSe][:LTE]:SFLatness:OBANd <NofSubbands>

This command selects the operating band for spectrum flatness Measurements.

Parameters:

<NofSubbands> <numeric value>

Range: 1 to 40
*RST: 1

Example: `SFL:OBAN 10`
Selects operating band 10.

Manual operation: See "Operating Band Index" on page 48

MIMO Configuration

CONFigure[:LTE]:UL:MIMO:ASELection <Antenna>

This command selects the antenna for measurements with MIMO setups.

Parameters:

<Antenna> **ANT1 | ANT2 | ANT3 | ANT4**
Select a single antenna to be analyzed
ALL
Select all antennas to be analyzed

Example: `CONF:UL:MIMO:ASEL ANT2`
Selects antenna 2 to be analyzed.

Manual operation: See "MIMO Configuration" on page 49

Subframe Configuration

CONFigure[:LTE]:UL:CSUBframes <NofSubframes>

This command selects the number of configurable subframes in the uplink signal.

Parameters:

<NofSubframes> Range: 1 to 10
*RST: 1

Example: `CONF:UL:CSUB 5`
Sets the number of configurable subframes to 5.

CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:CONT <Content>

This command allocates a PUCCH or PUSCH to an uplink allocation.

Parameters:

<Content>

NONE
Turns off the PUSCH and the PUCCH.

PUCCh
Turns on the PUCCH.

PUSCh
Turns on the PUSCH.

PSCC
Turns on the PUCCH as well as the PUSCH.

*RST: PUSC

Example:
`CONF:UL:SUBF8:ALL:CONT PUCC`
Subframe 8 contains a PUCCH.

Manual operation:
See "Enable PUCCH" on page 51
See "Enable PUSCH" on page 51

CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:MODulation <Modulation>

This command selects the modulation of an uplink allocation.

Parameters:

<Modulation> QPSK | QAM16 | QAM64

*RST: QPSK

Example:
`CONF:UL:SUBF8:ALL:MOD QPSK`
The modulation of the allocation in subframe 8 is QPSK.

Manual operation: See "Modulation" on page 52

CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:PRECoding:CBINdex <CBIndex>

This command selects the codebook index for a PUSCH allocation.

Parameters:

<CBIndex> Range: 0 to 5
*RST: 0

Example:
`CONF:UL:SUBF:ALL:PREC:CBIN 1`
Selects codebook index 1 for the PUSCH allocation.

Manual operation: See "Enhanced PUSCH Configuration" on page 52

CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:PRECoding:CLMapping <Mapping>

This command selects the codeword to layer mapping for a PUSCH allocation.

Parameters:

<Mapping> LC11 | LC21 | LC22

Example: `CONF:UL:SUBF2:ALL:PREC:CLM LC11`
Assigns codeword-to-layer mapping 1/1 to subframe 2.

Manual operation: See "Enhanced PUSCH Configuration" on page 52

CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:PUCCh:FORMat <Format>

This command selects the PUCCH format for a particular subframe.

The command is available if you have selected PUCCH format selection on subframe basis with `CONFigure[:LTE]:UL:PUCCh:FORMat`.

Parameters:

<Format>

F1N (F1 normal)

F1S (F1 shortened)

F1AN (F1a normal)

F1AS (F1a shortened)

F1BN (F1b normal)

F1BS (F1b shortened)

F2 (F2)

F2A (F2a)

F2B (F2b)

F3 (F3)

Example: `CONF:UL:SUBF4:ALL:PUCC:FORM F3`
Selects format F3 for the PUCCH in subframe 4.

Manual operation: See "Enhanced PUCCH Configuration" on page 54

CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:PUCCh:NPAR <Parameter>

This command defines N_PUCCH on a subframe basis.

The command is available if `CONFigure[:LTE]:UL:PUCCh:NPAR` on page 166 is turned on.

Parameters:

<Parameter>	<numeric value>

Example: `CONF:UL:SUBF:ALL:PUCC:NPAR 2`
Sets N_PUCCH to 2.

Manual operation: See "Enhanced PUCCH Configuration" on page 54

CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:PUSCh:CSField <CyclicShiftField>

This command defines the cyclic shift field of the demodulation reference signal.

Available if `CONFigure[:LTE]:UL[:CC<cci>]:DRS:AOCC` on page 157 has been turned on.

Parameters:

<CyclicShiftField> Range: 0 to 7
*RST: 0

Example: `CONF:UL:SUBF:ALL:PUSC:CSF 4`
Defines cyclic shift field 4.

Manual operation: See "Enhanced Demodulation Reference Signal Configuration" on page 53

CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:PUSCh:NDMRs <PuschNDMRS>

This command defines the part of the DMRS index that is used for the uplink scheduling assignment.

Parameters:

<PuschNDMRS> <numeric value>
Range: 0 to 11
*RST: 0

Example: `CONF:UL:SUBF:ALL:PUSC:NDMR 2`
Defines index 2.

Manual operation: See "Enhanced Demodulation Reference Signal Configuration" on page 53

CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc:RATO <State>

This command turns the resource allocation type 1 on and off.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CONF:UL:SUBF:ALL:RATO ON`
Turns resource allocation type 1 on.

Manual operation: See "Enhanced PUSCH Configuration" on page 52

CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc[:CLUSter<cluster>]:RBCount <ResourceBlocks>

This command selects the number of resource blocks in an uplink subframe.

Parameters:

<NofRBs> <numeric value>
*RST: 11

Example: `CONF:UL:SUBF8:ALL:RBC 8`
Subframe 8 consists of 8 resource blocks.

Manual operation: See "Number of RB" on page 52

CONFigure[:LTE]:UL[:CC<cci>]:SUBFrame<subframe>:ALLoc[:CLUSter<cluster>]:RBOFfset <Offset>

This command defines the resource block offset in an uplink subframe.

Parameters:
<RBOffset> <numeric value>
*RST: 2

Example: `CONF:UL:SUBF8:ALL:RBOF 5`
Subframe 8 has a resource block offset of 5.

Manual operation: See "Offset RB" on page 52

[SENSe][:LTE]:UL:DEMod:ACON <Type>

This command selects the method of automatic demodulation for uplink signals.

Parameters:
<Type>

ALL
Automatically detects and demodulates the PUSCH and SRS.

OFF
Automatic demodulation is off.

SCON
Automatically detects and demodulates the values available in the subframe configuration table.

Example: `UL:DEM:ACON OFF`
Turns automatic demodulation off.

Manual operation: See "Auto Demodulation" on page 50

[SENSe][:LTE]:UL:FORMat:SCD <State>

This command turns detection of the subframe configuration on and off.

The command is available if "Auto Demodulation" is turned off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `UL:FORM:SCD ON`
Turns detection of the subframe configuration on.

Manual operation: See "Subframe Configuration Detection" on page 50

Global Settings

CONFigure[:LTE]:UL:SFNO <Offset>

This command defines the system frame number offset.

The application uses the offset to demodulate the frame.

Parameters:

<Offset> <numeric value>

*RST: 0

Example: `CONF:UL:SFNO 2`

Selects frame number offset 2.

Manual operation: See "Frame Number Offset" on page 55

CONFigure[:LTE]:UL:UEID <ID>

Sets the radio network temporary identifier (RNTI) of the UE.

Parameters:

<ID> <numeric value>

*RST: 0

Example: `CONF:UL:UEID 2`

Sets the UE ID to 2.

Manual operation: See "UE ID/n_RNTI" on page 55

Demodulation Reference Signal

CONFigure[:LTE]:UL[:CC<cci>]:DRS:AOCC <State>

This command turns the configuration of the demodulation reference signal on a subframe basis via the "Cyclic Field Shift" on and off.

Parameters:

<State> ON | OFF

Example: `CONF:UL:DRS:AOCC ON`

Turns Activate-DMRS-with OCC on.

Manual operation: See "Activate-DMRS-With OCC" on page 57

CONFigure[:LTE]:UL[:CC<cci>]:DRS:DSSHift <Shift>

This command selects the delta sequence shift of the uplink signal.

Parameters:

<Shift> <numeric value>

*RST: 0

Example: `CONF:UL:DRS:DSSH 3`

Sets the delta sequence shift to 3.

Manual operation: See " Delta Sequence Shift" on page 57

CONFigure[:LTE]:UL[:CC<cci>]:DRS:GRPHopping <State>

This command turns group hopping for uplink signals on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CONF:UL:DRS:GRPHopping ON`

Activates group hopping.

Manual operation: See " Group Hopping" on page 56

CONFigure[:LTE]:UL[:CC<cci>]:DRS:NDMRs <nDMRS>

This command defines the n_{DMRS}.

Parameters:

<nDMRS> <numeric value>

Example: `CONF:UL:DRS:NDMR 0`

Selects n_{DMRS} 0.

Manual operation: See " n(1)_DMRS" on page 57

CONFigure[:LTE]:UL[:CC<cci>]:DRS:PUCCh:POWer <Power>

This command sets the relative power of the PUCCH.

Parameters:

<Power> *RST: 0

Default unit: DB

Example: `CONF:UL:DRS:PUCC:POW 2`

Sets the power of the PUCCH to 2 dB.

Manual operation: See " Relative Power PUCCH" on page 57

CONFigure[:LTE]:UL[:CC<cci>]:DRS[:PUSCh]:POWer <Power>

This command sets the relative power of the PUSCH.

Parameters:

<Power>	*RST:	0
	Default unit:	DB

Example: `CONF:UL:DRS:POW 2`
Sets the relative power of the PUSCH to 2 dB.

Manual operation: See " Relative Power PUSCH" on page 56

CONFigure[:LTE]:UL[:CC<cci>]:DRS:SEQHopping <State>

This command turns sequence hopping for uplink signals on and off.

Parameters:

<State>	ON | OFF	
	*RST:	OFF

Example: `CONF:UL:DRS:SEQH ON`
Activates sequence hopping.

Manual operation: See " Sequence Hopping" on page 56

Sounding Reference Signal

CONFigure[:LTE]:UL:SRS:ANST <State>

This command turns simultaneous transmission of the Sounding Reference Signal (SRS) and ACK/NACK messages (via PUCCH) on and off.

Simultaneous transmission works only if the PUCCH format ist either 1, 1a, 1b or 3.

Parameters:

<State>

ON
Allows simultaneous transmission of SRS and PUCCH.

OFF
SRS not transmitted in the subframe for which you have configured simultaneous transmission of PUCCH and SRS.

Example: `CONF:UL:SRS:ANST ON`
Turns simultaneous transmission of the SRS and PUCCH in one subframe on.

Manual operation: See "A/N + SRS Simultaneous TX" on page 61

CONFigure[:LTE]:UL:SRS:BHOP <Bandwidth>

This command defines the frequency hopping bandwidth b_{hop}.

Parameters:

<Bandwidth> <numeric value>

*RST: 0

Example: `CONF:UL:SRS:BHOP 1`
Sets the frequency hopping bandwidth to 1.

Manual operation: See " Hopping BW b_hop" on page 59

CONFigure[:LTE]:UL:SRS:BSRS <Bandwidth>

This command defines the bandwidth of the SRS (B_{SRS}).

Parameters:

<Bandwidth> <numeric value>

*RST: 0

Example: `CONF:UL:SRS:BSRS 1`
Sets the SRS bandwidth to 1.

Manual operation: See " SRS Bandwidth B_SRS" on page 59

CONFigure[:LTE]:UL:SRS:CSRS <Configuration>

This command defines the SRS bandwidth configuration (C_{SRS}).

Parameters:

<Configuration> <numeric value>

*RST: 0

Example: `CONF:UL:SRS:CSRS 2`
Sets the SRS bandwidth configuration to 2.

Manual operation: See " SRS BW Conf. C_SRS" on page 60

CONFigure[:LTE]:UL:SRS:CYCS <CyclicShift>

Sets the cyclic shift n_CS used for the generation of the sounding reference signal CAZAC sequence.

Parameters:

<CyclicShift> <numeric value>

*RST: 0

Example: `CONF:UL:SRS:CYCS 2`

Sets the cyclic shift to 2.

Manual operation: See " SRS Cyclic Shift N_CS" on page 59

CONFigure[:LTE]:UL:SRS:ISRS <ConfIndex>

This command defines the SRS configuration index (I_{SRS}).

Parameters:

<ConfIndex> <numeric value>

*RST: 0

Example: `CONF:UL:SRS:ISRS 1`

Sets the configuration index to 1.

Manual operation: See " Conf. Index I_SRS" on page 60

CONFigure[:LTE]:UL:SRS:MUPT <State>

This command turns SRS MaxUpPts on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See "SRS MaxUpPts" on page 59

CONFigure[:LTE]:UL:SRS:NRRC <FreqDomPos>

Sets the UE specific parameter Freq. Domain Position n_{RRC}.

Parameters:

<FreqDomPos> <numeric value>

*RST: 0

Example: `CONF:UL:SRS:NRRC 1`

Sets n_{RRC} to 1.

Manual operation: See " Freq. Domain Pos. n_RRC" on page 60

CONFigure[:LTE]:UL:SRS:POWer <Power>

Defines the relative power of the sounding reference signal.

Parameters:

<Power> <numeric value>

*RST: 0

Default unit: DB

Example: `CONF:UL:SRS:POW -1.2`

Sets the power to -1.2 dB.

Manual operation: See " SRS Rel Power" on page 60

CONFigure[:LTE]:UL:SRS:STAT <State>

Activates or deactivates the sounding reference signal.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CONF:UL:SRS:STAT ON`

Activates the sounding reference signal.

Manual operation: See " Present" on page 58

CONFigure[:LTE]:UL:SRS:SUConfig <Configuration>

This command defines the SRS subframe configuration.

Parameters:

<Configuration> <numeric value>

*RST: 0

Example: `CONF:UL:SRS:SUC 4`

Sets SRS subframe configuration to 4.

Manual operation: See " SRS Subframe Conf." on page 58

CONFigure[:LTE]:UL:SRS:TRComb <TransComb>

This command defines the transmission comb (k_{TC}).

Parameters:

<TransComb> <numeric value>

*RST: 0

Example: `CONF:UL:SRS:TRC 1`

Sets transmission comb to 1.

Manual operation: See " Transm. Comb. k_TC" on page 60

PUSCH Structure

CONFigure[:LTE]:UL[:CC<cci>]:PUSCh:FHMode <HoppingMode>

This command selects the frequency hopping mode in the PUSCH structure.

Parameters:

<HoppingMode>

NONE
No hopping

INTer
Inter subframe hopping

INTRa
Intra subframe hopping

*RST: NONE

Example: `CONF:UL:PUSC:FHM NONE`
Deactivates frequency hopping for the PUSCH.

Manual operation: See " Frequency Hopping Mode" on page 61

CONFigure[:LTE]:UL[:CC<cci>]:PUSCh:FHOFfset <Offset>

This command defines the frequency hopping offset for the PUSCH.

Parameters:

<Offset> <numeric value>

*RST: 4

Example: `CONF:UL:PUSC:FHOF 5`
Sets the hopping offset to 5.

Manual operation: See " PUSCH Hopping Offset" on page 62

CONFigure[:LTE]:UL[:CC<cci>]:PUSCh:FHOP:IIHB <HBInfo>

This command defines the information in hopping bits of the PUSCH.

Parameters:

<HBInfo> <numeric value>

Range: 0 to 3
*RST: 0

Example: `CONF:UL:PUSC:FHOP:IIHB 1`
Defines type 1 as the information in hopping bits.

Manual operation: See " Info. in Hopping Bits" on page 62

CONFigure[:LTE]:UL[:CC<cci>]:PUSCh:NOSM <NofSubbands>

This command defines the number of subbands/M of the PUSCH.

Parameters:

<NofSubbands> <numeric value>

*RST: 4

Example: `CONF:UL:PUSC:NOSM 2`

Sets the number of subbands to 2.

Manual operation: See " Number of Subbands" on page 62

PUCCH Structure

CONFigure[:LTE]:UL:PUCCh:DESHift <Shift>

This command defines the delta shift of the PUCCH.

Parameters:

<Shift> <numeric value>

Range: 1 to 3
*RST: 2

Example: `CONF:UL:PUCC:DESH 3`

Sets the delta shift of the PUCCH to 3.

Manual operation: See " Delta Shift" on page 64

CONFigure[:LTE]:UL:PUCCh:FORMat <Format>

This command selects the PUCCH format.

Note that formats 2a and 2b are available for normal cyclic prefix length only.

Parameters:

<Format>

F1 (F1)

F1A (F1a)

F1B (F1b)

F2 (F2)

F2A (F2a)

F2B (F2b)

F3 (F3)

SUBF

Allows you to define the PUCCH format for each subframe separately with .

*RST: F1

Example: `CONF:UL:PUCC:FORM F1B`

Sets the PUCCH format to F1B.

Manual operation: See " Format" on page 64

CONFigure[:LTE]:UL:PUCCh:N1CS <N1cs>

This command defines the N(1)_cs of the PUCCH.

Parameters:

<N1cs> <numeric value>

*RST: 6

Example: `CONF:UL:PUCC:N1CS 4`

Sets N(1)_cs to 4.

Manual operation: See " N(1)_cs" on page 63

CONFigure[:LTE]:UL:PUCCh:N2RB <N2RB>

This command defines the N(2)_RB of the PUCCH.

Parameters:

<N2RB> <numeric value>

*RST: 1

Example: `CONF:UL:PUCC:N2RB 2`

Sets N2_RB to 2.

Manual operation: See " N(2)_RB" on page 64

CONFigure[:LTE]:UL:PUCCh:NORB <ResourceBlocks>

This command selects the number of resource blocks for the PUCCH.

Parameters:

<ResourceBlocks> **<numeric value>**
Selects the number of RBs.

AUTO
Detects the number of RBs automatically.

*RST: 0

Example: `CONF:UL:PUCC:NORB 6`
Sets the number of resource blocks to 6.

Manual operation: See " No. of RBs for PUCCH" on page 63

CONFigure[:LTE]:UL:PUCCh:NPAR <Format>

This command defines the N_PUCCH parameter in the PUCCH structure settings.

Parameters:

<Format> <numeric value>

<numeric value>

SUBF
Selects the definition of N_PUCCH on subframe level.

*RST: 0

Example: `CONF:UL:PUCC:NPAR 2`
Sets N_PUCCH to 2.

Manual operation: See " N_PUCCH" on page 64

PRACH Structure

CONFigure[:LTE]:UL:PRACh:APM <State>

This command turns automatic preamble mapping for the PRACH on and off.

Parameters:

<State> ON | OFF

Example: `CONF:UL:PRAC:APM ON`
Turns automatic preamble mapping on.

Manual operation: See "PRACH Preamble Mapping" on page 66

CONFigure[:LTE]:UL:PRACh:CONF <Configuration>

This command selects the PRACH preamble format.

Parameters:

<Configuration> <numeric value>

Example: `CONF:UL:PRAC:CONF 2`
Selects PRACH configuration 2.

Manual operation: See "PRACH Configuration" on page 65

CONFigure[:LTE]:UL:PRACh:FOFFset <Offset>

This command defines the PRACH frequency offset.

The command is available for preamble formats 0 to 3.

Parameters:

<Offset> Resource block offset.

Example: `CONF:UL:PRAC:FOFF 5`
Defines a frequency offset of 5 resource blocks.

Manual operation: See "Frequency Offset" on page 66

CONFigure[:LTE]:UL:PRACh:FRINdex <FRINdex>

This command selects the PRACH frequency index.

Parameters:

<FRINdex> <numeric value>

Example: `CONF:UL:PRAC:FRIN 10`
Selects the frequency index 10.

Manual operation: See "PRACH Preamble Mapping" on page 66

CONFigure[:LTE]:UL:PRACh:HFINdicator <HFINdicator>

This command defines the PRACH half frame indicator.

Parameters:

<HFINdicator> <numeric value>

Example: `CONF:UL:PRAC:HFIN 5`
Selects half frame indicator 5.

Manual operation: See "PRACH Preamble Mapping" on page 66

CONFigure[:LTE]:UL:PRACh:NCSC <Configuration>

This command defines the Ncs configuration for the PRACH.

Parameters:

<Configuration> <numeric value>

Example: `CONF:UL:PRAC:NCSC 1`
Selects Ncs configuration 1.

Manual operation: See "Ncs Conf" on page 66

CONFigure[:LTE]:UL:PRACh:RSEQ <RootSeqIdx>

This command defines the PRACH logical root sequence index.

Parameters:

<RootSeqIdx> <numeric value>

Example: `CONF:UL:PRAC:RSEQ 2`
Selects logical root sequence index 2.

Manual operation: See "Logical Root Sequ. Idx" on page 66

CONFigure[:LTE]:UL:PRACh:RSET <State>

This command turns the restricted preamble set for PRACH on and off.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `CONF:UL:PRAC:RSET ON`
Turns the restricted set on.

Manual operation: See "Restricted Set" on page 65

CONFigure[:LTE]:UL:PRACh:SINDex <Index>

This command selects the PRACH sequence index.

Parameters:

<Index> **<IndexValue>**
Number that defines the index manually.
AUTO
Automatcailly determines the index.

Example: `CONF:UL:PRAC:SIND 2`
Selects sequence index 2.

Manual operation: See "Sequence Index (v)" on page 66

6.10.2.2 Input / Frontend

Configuring the Input

Remote commands to configure the input described elsewhere:

- `INPut:COUPling` on page 180
- `INPut:IMPedance` on page 181
- `[SENSe]:SWAPiq` on page 183

CALibration:AIQ:HATiming[:STATe] <State>

Activates a mode with enhanced timing accuracy between analog baseband, RF and external trigger signals.

For more information see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

Parameters:

<State> ON | OFF | 1 | 0

ON | 1
The high accuracy timing function is switched on.
The cable for high accuracy timing must be connected to trigger ports 1 and 2.

OFF | 0
The high accuracy timing function is switched off.

*RST: OFF

Example: `CAL:AIQ:HAT:STAT ON`

Manual operation: See "High Accuracy Timing Trigger - Baseband - RF" on page 71

INPut:CONNector <ConnType>

Determines whether the RF input data is taken from the RF input connector or the optional Analog Baseband I connector. This command is only available if the Analog Baseband interface (R&S FSW-B71) is installed and active for input. It is not available for the R&S FSW67 or R&S FSW85.

For more information on the Analog Baseband Interface (R&S FSW-B71) see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

Parameters:

<ConnType>

RF
RF input connector

AIQI
Analog Baseband I connector

*RST: RF

Example: `INP:CONN:AIQI`
Selects the analog baseband input.

Usage: SCPI confirmed

Manual operation: See "Input Connector" on page 68

INPut:DIQ:CDEVice

This command queries the current configuration and the status of the digital I/Q input from the optional Digital Baseband Interface.

For details see the section "Interface Status Information" for the optional Digital Baseband Interface in the R&S FSW I/Q Analyzer User Manual.

Return values:

<ConnState> Defines whether a device is connected or not.

0
No device is connected.

1
A device is connected.

<DeviceName> Device ID of the connected device

<SerialNumber> Serial number of the connected device

<PortName> Port name used by the connected device

<SampleRate> Maximum or currently used sample rate of the connected device in Hz (depends on the used connection protocol version; indicated by <SampleRateType> parameter)

<MaxTransferRate> Maximum data transfer rate of the connected device in Hz

<ConnProtState>	State of the connection protocol which is used to identify the connected device. **Not Started** **Has to be Started** **Started** **Passed** **Failed** **Done**
<PRBSTestState>	State of the PRBS test. **Not Started** **Has to be Started** **Started** **Passed** **Failed** **Done**
<SampleRateType>	**0** Maximum sample rate is displayed **1** Current sample rate is displayed
<FullScaleLevel>	The level (in dBm) that should correspond to an I/Q sample with the magnitude "1" (if transferred from connected device); If not available, `1.#QNAN` (not a number) is returned

Example:	`INP:DIQ:CDEV?`
	Result:
	`1,SMW200A,101190,BBMM 1 OUT,`
	`100000000,200000000,Passed,Passed,1,1.#QNAN`

Manual operation:	See "Connected Instrument" on page 69

INPut:DIQ:RANGe[:UPPer]:AUTO <State>

If enabled, the digital input full scale level is automatically set to the value provided by the connected device (if available).

This command is only available if the optional Digital Baseband interface is installed.

Parameters:

<State>	ON | OFF *RST: OFF
Manual operation:	See "Full Scale Level" on page 69

INPut:DIQ:RANGe:COUPling <State>

If enabled, the reference level for digital input is adjusted to the full scale level automatically if the full scale level changes.

This command is only available if the optional Digital Baseband Interface is installed.

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See "Adjust Reference Level to Full Scale Level" on page 69

INPut:DIQ:RANGe[:UPPer] <Level>

Defines or queries the "Full Scale Level", i.e. the level that corresponds to an I/Q sample with the magnitude "1".

This command is only available if the optional Digital Baseband Interface is installed.

Parameters:

<Level> <numeric value>

Range: 1 µV to 7.071 V
*RST: 1 V

Manual operation: See "Full Scale Level" on page 69

INPut:DIQ:RANGe[:UPPer]:UNIT <Unit>

Defines the unit of the full scale level (see "Full Scale Level" on page 69). The availability of units depends on the measurement application you are using.

This command is only available if the optional Digital Baseband Interface is installed.

Parameters:

<Level> VOLT | DBM | DBPW | WATT | DBMV | DBUV | DBUA | AMPere

*RST: Volt

Manual operation: See "Full Scale Level" on page 69

INPut:DIQ:SRATe <SampleRate>

This command specifies or queries the sample rate of the input signal from the optional Digital Baseband Interface (see "Input Sample Rate" on page 68).

Parameters:

<SampleRate> Range: 1 Hz to 10 GHz
*RST: 32 MHz

Example: INP:DIQ:SRAT 200 MHz

Manual operation: See "Input Sample Rate" on page 68

INPut:DIQ:SRATe:AUTO <State>

If enabled, the sample rate of the digital I/Q input signal is set automatically by the connected device.

This command is only available if the optional Digital Baseband Interface is installed.

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See "Input Sample Rate" on page 68

INPut:DPATh <State>

Enables or disables the use of the direct path for frequencies close to 0 Hz.

Parameters:

<State> **AUTO | 1**

(Default) the direct path is used automatically for frequencies close to 0 Hz.

OFF | 0

The analog mixer path is always used.

*RST: 1

Example: `INP:DPAT OFF`

Usage: SCPI confirmed

Manual operation: See "Direct Path" on page 67

INPut:FILTer:HPASs[:STATe] <State>

Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the R&S FSW in order to measure the harmonics for a DUT, for example.

This function requires an additional high-pass filter hardware option.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG filter.)

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:FILT:HPAS ON`

Turns on the filter.

Usage: SCPI confirmed

Manual operation: See "High-Pass Filter 1...3 GHz" on page 67

INPut:FILTer:YIG[:STATe] <State>

This command turns the YIG-preselector on and off.

Note the special conditions and restrictions for the YIG filter described in "YIG-Preselector" on page 68.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1 (0 for I/Q Analyzer, GSM, VSA and MC Group Delay measurements)

Example: `INP:FILT:YIG OFF`
Deactivates the YIG-preselector.

Manual operation: See "YIG-Preselector" on page 68

INPut:IQ:BALanced[:STATe] <State>

This command defines whether the input is provided as a differential signal via all 4 Analog Baseband connectors or as a plain I/Q signal via 2 single-ended lines.

Parameters:

<State>

ON
Differential

OFF
Single ended

*RST: ON

Example: `INP:IQ:BAL OFF`

Manual operation: See "Input Configuration" on page 71

INPut:IQ:TYPE <DataType>

This command defines the format of the input signal.

Parameters:

<DataType> IQ | I | Q

IQ
The input signal is filtered and resampled to the sample rate of the application.
Two input channels are required for each input signal, one for the in-phase component, and one for the quadrature component.

I
The in-phase component of the input signal is filtered and resampled to the sample rate of the application. If the center frequency is not 0, the in-phase component of the input signal is down-converted first (Low IF I).

Q
The quadrature component of the input signal is filtered and resampled to the sample rate of the application. If the center frequency is not 0, the quadrature component of the input signal is down-converted first (Low IF Q).

*RST: IQ

Example: `INP:IQ:TYPE Q`

Manual operation: See "I/Q Mode" on page 70

INPut:SELect <Source>

This command selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S FSW.

Parameters:

<Source>

RF
Radio Frequency ("RF INPUT" connector)

DIQ
Digital IQ data (only available with optional Digital Baseband Interface
For details on I/Q input see the R&S FSW I/Q Analyzer User Manual.

AIQ
Analog Baseband signal (only available with optional Analog Baseband Interface R&S FSW-B71)
For details on Analog Baseband input see the R&S FSW I/Q Analyzer User Manual.

*RST: RF

Manual operation: See "Digital I/Q Input State" on page 68
See "Analog Baseband Input State" on page 70

Defining the Frequency

[SENSe]:FREQuency:CENTer[:CC<cci>] <Frequency>

This command sets the center frequency for RF measurements.

Component carrier measurements

- Defining or querying the frequency of the first carrier is possible with `FREQ:CENT:CC1`. The `CC1` part of the syntax is mandatory in that case.
- `FREQ:CENT?` queries the measurement frequency (center of the two carriers).

Parameters:

<Frequency> <numeric value>

Range: fmin to fmax
*RST: 1 GHz
Default unit: Hz

Example: Measurement on one carrier:
`FREQ:CENT 1GHZ`
Defines a center frequency of 1 GHz

Example: Measurement on aggregated carriers:
`FREQ:CENT:CC1 850MHZ`
Defines a center frequency of 850 MHz for the first carrier.

Manual operation: See "Defining the Signal Frequency" on page 72
See "Remote commands to configure carrier aggregation" on page 83

[SENSe]:FREQuency:CENTer[:CC<cci>]:OFFSet <Frequency>

This command defines the general frequency offset or the frequency offset for a component carrier.

The effect of the command depends on the syntax:

- When you omit the `[CC<cci>]` syntax element, the command defines the overall frequency offset.
  In that case, the value is added to the measurement frequency and, in case of measurements with component carriers, the center frequency of the component carriers.
- When you include the `[CC<cci>]` syntax element, the command defines the offset of the component carrier relative the first component carrier.
  In that case, the command is not available for the first component carrier - thus, `...:CC1:...` is not possible.

Parameters:

<Frequency>
• General frequency offset: frequency offset in Hz.
• Component carrier offset: frequency offset relative to the first component carrier in Hz.

Example:
`FREQ:CENT:OFFS 50HZ`
Adds a frequency offset of 50 Hz to the measurement frequency. If you are measuring component carriers, the value is also added to the center frequencies of those carriers.
`FREQ:CENT:CC2:OFFS 15MHZ`
Defines a frequency offset of 15 MHz for the second component carrier relative to the first component carrier.

Manual operation:
See "Defining the Signal Frequency" on page 72
See "Remote commands to configure carrier aggregation" on page 83

[SENSe:]FREQuency:CENTer:STEP <StepSize>

This command defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the `SENS:FREQ UP` and `SENS:FREQ DOWN` commands, see `[SENSe]:FREQuency:CENTer[:CC<cci>]` on page 176.

Parameters:

<StepSize>
f_{max} is specified in the data sheet.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example:
`FREQ:CENT 100 MHz`
`FREQ:CENT:STEP 10 MHz`
`FREQ:CENT UP`
Sets the center frequency to 110 MHz.

Manual operation:
See "Defining the Signal Frequency" on page 72

[SENSe:]FREQuency:CENTer:STEP:LINK <CouplingType>

This command couples and decouples the center frequency step size to the span or the resolution bandwidth.

Parameters:

<CouplingType>
SPAN
Couples the step size to the span. Available for measurements in the frequency domain.
OFF
Decouples the step size.
*RST: SPAN

Example:
`FREQ:CENT:STEP:LINK SPAN`

[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor <Factor>

Parameters:

<Factor>	1 to 100 PCT *RST: 10
Example:	`FREQ:CENT:STEP:LINK:FACT 20PCT`

Configuring the Vertical Axis

CALCulate<n>:UNIT:POWer <Unit>

This command selects the unit of the y-axis.

The unit applies to all measurement windows.

Parameters:

<Unit>	DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere *RST: dBm
Example:	`CALC:UNIT:POW DBM` Sets the power unit to dBm.
Manual operation:	See "Defining a Reference Level" on page 73

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel <ReferenceLevel>

This command defines the reference level (for all traces, <t> is irrelevant).

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset.

Parameters:

<ReferenceLevel>	The unit is variable. Range: see datasheet *RST: 0 dBm
Example:	`DISP:TRAC:Y:RLEV -60dBm`

Usage: SCPI confirmed

Manual operation: See "Defining a Reference Level" on page 73

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet <Offset>

This command defines a reference level offset (for all traces, <t> is irrelevant).

Parameters:

<Offset> Range: -200 dB to 200 dB
*RST: 0dB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See "Defining a Reference Level" on page 73

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

If you set the attenuation manually, it is no longer coupled to the reference level, but the reference level is coupled to the attenuation. Thus, if the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Parameters:

<Attenuation> Range: see data sheet
Increment: 5 dB
*RST: 10 dB (AUTO is set to ON)

Example: `INP:ATT 30dB`
Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuating the Signal" on page 73

INPut:ATTenuation:AUTO <State>

This command couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the R&S FSW determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

Parameters:

<State> ON | OFF | 0 | 1
*RST: 1

Example: `INP:ATT:AUTO ON`
Couples the attenuation to the reference level.

Usage: SCPI confirmed

Manual operation: See "Attenuating the Signal" on page 73

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Parameters:

<CouplingType> **AC**
AC coupling

DC
DC coupling

*RST: AC

Example: `INP:COUP DC`

Usage: SCPI confirmed

Manual operation: See "Input Coupling" on page 74

INPut:GAIN[:VALue] <Gain>

This command selects the gain level if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut:GAIN:STATe` on page 180).

The command requires the additional preamplifier hardware option.

Parameters:

<Gain> 15 dB | 30 dB

The availability of gain levels depends on the model of the R&S FSW.
R&S FSW8/13: 15dB and 30 dB
R&S FSW26 or higher: 30 dB
All other values are rounded to the nearest of these two.

*RST: OFF

Example: `INP:GAIN:VAL 30`
Switches on 30 dB preamplification.

Usage: SCPI confirmed

INPut:GAIN:STATe <State>

This command turns the preamplifier on and off. It requires the optional preamplifiier hardware.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:GAIN:STAT ON`
Switches on 30 dB preamplification.

Usage: SCPI confirmed

INPut:IMPedance <Impedance>

This command selects the nominal input impedance of the RF input. In some applications, only 50 Ω are supported.

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a matching pad of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The power loss correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

Parameters:

<Impedance> 50 | 75

*RST: 50 Ω

Example: `INP:IMP 75`

Usage: SCPI confirmed

Manual operation: See "Impedance" on page 74

INPut<n>:EATT <Attenuation>

This command defines the electronic attenuation level.

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

This command is available with the optional Electronic Attenuator, but not if you are using the optional Digital Baseband Input.

Parameters:

<Attenuation> Attenuation level in dB.

Default unit: dB

Example: `INP:EATT 10`

Defines an attenuation level of 10 dB.

Manual operation: See "Attenuating the Signal" on page 73

INPut<n>:EATT:AUTO <State>

This command turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

This command is available with the optional Electronic Attenuator, but not if you are using the optional Digital Baseband Input.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:EATT:AUTO ON`

Turns automatic selection of electronic attenuation level on.

Manual operation: See "Attenuating the Signal" on page 73

INPut<n>:EATT:STATe <State>

This command turns the electronic attenuator on and off.

This command is available with the optional Electronic Attenuator, but not if you are using the optional Digital Baseband Input.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:EATT:STAT ON`

Turns the electronic attenuator on.

Manual operation: See "Attenuating the Signal" on page 73

[SENSe:]ADJust:LEVel

This command initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. This ensures that the settings of the RF attenuation and the reference level are optimally adjusted to the signal level without overloading the R&S FSW or limiting the dynamic range by an S/N ratio that is too small.

Example: `ADJ:LEV`

Usage: Event

Manual operation: See "Defining a Reference Level" on page 73

6.10.2.3 Signal Capture

Data Capture

[SENSe][:LTE]:FRAMe:COUNt <Subframes>

This command sets the number of frames you want to analyze.

Parameters:

<Subframes> <numeric value>

*RST: 1

Example: `FRAM:COUN:STAT ON`
`FRAM:COUN:AUTO OFF`
Activates manual input of frames to be analyzed.
`FRAM:COUN 20`
Analyzes 20 frames.

Manual operation: See "Number of Frames to Analyze" on page 76

[SENSe][:LTE]:FRAMe:COUNt:AUTO <State>

This command turns automatic selection of the number of frames to analyze on and off.

Parameters:
<State> **ON**
Selects the number of frames to analyze according to the LTE standard.
OFF
Turns manual selection of the frame number on.

Example: `FRAM:COUN:AUTO ON`
Turns automatic selection of the analyzed frames on.

Manual operation: See "Auto According to Standard" on page 76

[SENSe][:LTE]:FRAMe:COUNt:STATe <State>

This command turns manual selection of the number of frames you want to analyze on and off.

Parameters:
<State> **ON**
You can set the number of frames to analyze.
OFF
The R&S FSW analyzes a single sweep.
*RST: ON

Example: `FRAM:COUN:STAT ON`
Turns manual setting of number of frames to analyze on.

Manual operation: See "Overall Frame Count" on page 76

[SENSe]:SWAPiq <State>

This command turns a swap of the I and Q branches on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `SWAP ON`
Turns a swap of the I and Q branches on.

Manual operation: See "Swap I/Q" on page 76

[SENSe]:SWEep:TIME <CaptLength>

This command sets the capture time.

Parameters:

<CaptLength> Numeric value in seconds.

Default unit: s

Example: `SWE:TIME 40ms`

Defines a capture time of 40 milliseconds.

Manual operation: See "Capture Time" on page 75

Trigger

The trigger functionality of the LTE measurement application is the same as that of the R&S FSW.

For a comprehensive description of the available remote control commands for trigger configuration see the documentation of the R&S FSW.

TRIGger[:SEQuence]:HOLDoff<instrument> <Offset>

This command defines the trigger offset.

Parameters:

<Offset> <numeric value>

*RST: 0 s

Default unit: s

Example: `TRIG:HOLD 5MS`

Sets the trigger offset to 5 ms.

TRIGger[:SEQuence]:LEVel<instrument>[:EXTernal] <Level>

This command defines the level for an external trigger.

Parameters:

<Level> Range: 0.5 V to 3.5 V

*RST: 1.4 V

Default unit: V

Example: `TRIG:LEV 2V`

Defines a trigger level of 2 V.

TRIGger[:SEQuence]:PORT<instrument> <Port>

This command selects the trigger port for measurements with devices that have several trigger ports.

Parameters:

<Port>

PORT1

PORT2

PORT3

Example: `TRIG:PORT PORT1`
Selects trigger port 1.

TRIGger[:SEQuence]:SLOPe <Type>

For external and time domain trigger sources you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

Parameters:

<Type> POSitive | NEGative

POSitive
Triggers when the signal rises to the trigger level (rising edge).

NEGative
Triggers when the signal drops to the trigger level (falling edge).

*RST: POSitive

Example: `TRIG:SLOP NEG`

TRIGger[:SEQuence]:SOURce <Source>

This command selects the trigger source.

Note on external triggers:

If a measurement is configured to wait for an external trigger signal in a remote control program, remote control is blocked until the trigger is received and the program can continue. Make sure this situation is avoided in your remote control programs.

Parameters:

<Source>

IMMediate
Free Run

EXTernal
Trigger signal from the TRIGGER INPUT connector.

EXT2
Trigger signal from the TRIGGER INPUT/OUTPUT connector.
Note: Connector must be configured for "Input".

EXT3
Trigger signal from the TRIGGER 3 INPUT/ OUTPUT connector.
Note: Connector must be configured for "Input".

RFPower
First intermediate frequency

IFPower
Second intermediate frequency

IQPower
Magnitude of sampled I/Q data
For applications that process I/Q data, such as the I/Q Analyzer or optional applications.

TIME
Time interval

BBPower
Baseband power (for digital input via the optional Digital Baseband Interface
Baseband power (for digital input via the optional Digital Baseband Interface or the optional Analog Baseband interface

PSEN
External power sensor

GP0 | GP1 | GP2 | GP3 | GP4 | GP5
For applications that process I/Q data, such as the I/Q Analyzer or optional applications, and only if the optional Digital Baseband Interface is available.
Defines triggering of the measurement directly via the LVDS connector. The parameter specifies which general purpose bit (0 to 5) will provide the trigger data.

TUNit
If activated, the measurement is triggered by a connected R&S FS-Z11 trigger unit, simultaneously for all connected analyzers.

*RST: IMMediate

Example:

```
TRIG:SOUR EXT
```

Selects the external trigger input as source of the trigger signal

6.10.2.4 Demodulation

[SENSe][:LTE]:UL:DEMod:ATTSlots <State>

This command includes or excludes the transient slots present after a switch from downlink to uplink in the analysis.

Parameters:

<State> ON | OFF

Example: `UL:DEM:ATTS ON`
Includes the transient slots in the analysis.

Manual operation: See "Analyze TDD Transient Slots" on page 79

[SENSe][:LTE]:UL:DEMod:MODE <Reference>

This command selects the uplink analysis mode.

Parameters:

<Reference>

PUSCh
Analyzes the PUSCH and PUCCH.

PRACh
Analyzes the PRACH.

*RST: PUSCh

Example: `UL:DEM:MODE PRAC`
Selects PRACH analysis mode.

Manual operation: See "Analysis Mode" on page 78

[SENSe][:LTE]:UL:DEMod:CESTimation <Type>

This command selects the channel estimation type for uplink signals.

Parameters:

<Type> PIL | PILPAY

PIL
Pilot only

PILP
Pilot and payload

*RST: PILP

Example: `UL:DEM:CEST PIL`
Uses only the pilot signal for channel estimation.

Manual operation: See "Channel Estimation Range" on page 78

[SENSe][:LTE]:UL:DEMod:EEPeriod <State>

This command includes or excludes the exclusion period from EVM results.

Parameters:
<State> ON | OFF

Example: `UL:DEM:EEP ON`
Turns the exclusion periods for EVM calculation on.

Manual operation: See "EVM with Exclusion Period" on page 79

[SENSe][:LTE]:UL:DEMod:CDCoffset <State>

This command turns DC offset compensation for uplink signals on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `UL:DEM:CDC OFF`
Deactivates DC offset compensation.

Manual operation: See "Compensate DC Offset" on page 79

[SENSe][:LTE]:UL:DEMod:CBSCrambling <State>

This command turns scrambling of coded bits for uplink signals on and off.

Parameters:
<State> ON | OFF
*RST: ON

Example: `UL:DEM:CBSC OFF`
Deactivates the scrambling.

Manual operation: See "Scrambling of Coded Bits" on page 79

[SENSe][:LTE]:UL:DEMod:SISYnc <State>

This command turns suppressed interference synchronization on and off.

Parameters:
<State> ON | OFF
*RST: OFF

Example: `UL:DEM:SISY ON`
Turns suppressed interference synchronization on.

Manual operation: See "Suppressed Interference Synchronization" on page 80

[SENSe][:LTE]:UL:DEMod:MCFilter <State>

This command turns suppression of interfering neighboring carriers on and off (e.g. LTE, WCDMA, GSM etc).

Parameters:

<State> ON | OFF

*RST: OFF

Example: `UL:DEM:MCF ON`

Turns suppression on of neighboring carriers on.

Manual operation: See "Multicarrier Filter" on page 80

6.10.2.5 Tracking

[SENSe][:LTE]:UL:TRACking:PHASe <Type>

This command selects the phase tracking type for uplink signals.

Parameters:

<Type>

OFF
Deactivate phase tracking

PIL
Pilot only

PILP
Pilot and payload

*RST: OFF

Example: `SENS:UL:TRAC:PHAS PILP`

Use pilots and payload for channel estimation.

Manual operation: See "Phase" on page 77

[SENSe][:LTE]:UL:TRACking:TIME <State>

This command turns timing tracking for uplink signals on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `UL:TRAC:TIME ON`

Activates timing tracking.

Manual operation: See "Timing" on page 78

6.10.3 Configuring Time Alignment Measurements

All commands specific to the Transmit On/Off Power measurement are listed below.

Commands to configure Transmit On/Off Power measurement described elsewhere:

- `[SENSe]:FREQuency:CENTer[:CC<cci>]` on page 176
- Commands in "Subframe Configuration" on page 152
- Commands in "Demodulation Reference Signal" on page 157
- Commands in "PUSCH Structure" on page 163

CONFigure[:LTE]:CAGGregation:STATe <State>

This command turns carrier aggregation for Time Alignment measurements on and off.

You can select the number of component carriers with `CONFigure:NOCC`.

Parameters:

<State> ON | OFF

*RST: OFF

Example:

```
CONF:CAGG:STAT ON
CONF:NOCC 2
```

Turns carrier aggregation on and selects two component carriers.

CONFigure:NOCC <Carriers>

This command selects the number of component carriers evaluated in the Time Alignment measurement.

Parameters:

<Carriers> Number of the component carriers that you would like to measure. The range depends on the measurement.
For more information see "Carrier Aggregation" on page 81.

*RST: 1

Example:

```
CONF:NOCC 2
```

Selects 2 carriers.

Manual operation: See "Remote commands to configure carrier aggregation" on page 83

6.10.4 Configuring Frequency Sweep Measurements

Please refer to the documentation of the R&S FSW base unit for a comprehensive list and description of remote commands necessary to configure and perform frequency sweep measurements (ACLR and SEM).

All commands specific to the LTE application are listed below.

Commands to configure frequency sweep measurements described elsewhere:

- `[SENSe]:FREQuency:CENTer[:CC<cci>]:OFFSet` on page 176

CONFigure[:LTE]:UL:CABW <Bandwidth>

This command selects the channel bandwidth(s) of the carriers in MC ACLR measurements.

Parameters:

<Bandwidth>

B520
First carrier: 5 MHz, second carrier: 20 MHz bandwidth.

B1020
First carrier: 10 MHz, second carrier: 20 MHz bandwidth.

B1515
First carrier: 15 MHz, second carrier: 15 MHz bandwidth.

B1520
First carrier: 15 MHz, second carrier: 20 MHz bandwidth.

B2020
First carrier: 20 MHz, second carrier: 20 MHz bandwidth.

USER
Custom combination of bandwidths. Define the bandwidths of both carriers with `CONFigure[:LTE]:UL[:CC<cci>]:BW` on page 148.

Example:

```
CONF:UL:CABW USER
CONF:UL:CC1:BW BW5_00
CONF:UL:CC2:BW BW5_00
```

Custom bandwidth combination: first carrier 5 MHz, second carrier 5 MHz.

Manual operation: See "Remote commands to configure carrier aggregation" on page 83

CONFigure[:LTE]:NDEV <Devices>

This command selects the number of R&S FSW used in a Time Alignment Error measurement with carrier aggregation.

(Note that for uplink Time Alignment measurements, the number of devices is always '1'.)

Parameters:

<Devices>

1
Performs a broadband measurement over all component carriers on a single R&S FSW.

2
Performs a measurement on two R&S FSW, each one analyzing a single component carrier.

*RST: 1

Example:
`CONF:NDEV 1`
Selects a broadband measurement over all CCs.

Manual operation: See "Remote commands to configure carrier aggregation" on page 83

[SENSe]:POWer:ACHannel:AACHannel <Bandwidth>

This command selects the bandwidth of the adjacent channel for ACLR measurements.

Parameters:

<Channel>

EUTRA
Selects an EUTRA signal of the same bandwidth like the TX channel as assumed adjacent channel carrier.

UTRA128
Selects an UTRA signal with a bandwidth of 1.28MHz as assumed adjacent channel carrier.

UTRA384
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

UTRA768
Selects an UTRA signal with a bandwidth of 7.68MHz as assumed adjacent channel carrier.

*RST: EUTRA

Example:
`POW:ACH:AACH UTRA384`
Selects an UTRA signal with a bandwidth of 3.84MHz as assumed adjacent channel carrier.

Manual operation: See "Assumed Adjacent Channel Carrier" on page 84

[SENSe]:POWer:SEM:UL:REQuirement <Requirement>

This command selects the requirements for a spectrum emission mask.

Parameters:
<Requirement> GEN | NS3 | NS4 | NS67

GEN
General spectrum emission mask.

NS3 | NS4 | NS67
Spectrum emission masks with additional requirements.

Example: `POW:SEM:UL:REQ NS3`
Selects a spectrum emission mask with requirement for network signalled value NS3.

Manual operation: See "SEM Requirement" on page 84

6.11 Analysis

6.11.1 Evaluation Range

[SENSe][:LTE]:ALLocation:SELect <Allocation>

This command filters the displayed results in the constellation diagram by a particular type of allocation.

Parameters:
<Allocation> **ALL**
Shows the results for all allocations.

<numeric_value>
Shows the results for a particular allocation type.
Allocation types are mapped to numeric values. For the code assignment see chapter 6.7.1.20, "Return Value Codes", on page 122.

*RST: ALL

Example: `ALL:SEL 2`
Shows the results for PDSCH allocation 2.

Manual operation: See "Evaluation Range for the Constellation Diagram" on page 88

[SENSe][:LTE]:CARRier:SELect <Carrier>

This command filters the displayed results in the constellation diagram by a particular subcarrier.

Parameters:

<Carrier>

ALL
Shows the results for all subcarriers.

<numeric_value>
Shows the results for a particular subcarrier.

*RST: ALL

Example: `CARR:SEL 1`
Shows the results for subcarrier 1.

Manual operation: See "Evaluation Range for the Constellation Diagram" on page 88

[SENSe][:LTE]:MODulation:SELect <Modulation>

This command filters the displayed results in the constellation diagram by a particular type of modulation.

Parameters:

<Modulation>

ALL
Shows the results for all modulation types.

<numeric_value>
Shows the results for a particular modulation type.
Modulation types are mapped to numeric values. For the code assignment see chapter 6.7.1.20, "Return Value Codes", on page 122.

*RST: ALL

Example: `MOD:SEL 3`
Shows the results for all elements with a 16QAM modulation

Manual operation: See "Evaluation Range for the Constellation Diagram" on page 88

[SENSe][:LTE]:PREamble:SELect <Subframe>

This command selects a particular preamble for measurements that analyze individual preambles.

The command is available in PRACH analysis mode.

Parameters:
<Subframe> **ALL**
Analyzes all preambles.
<numeric value>
Selects the premable to analyze.
*RST: ALL

Example: `PRE:SEL ALL`
Analyzes all preambles.

Manual operation: See "Preamble Selection" on page 88

[SENSe][:LTE]:SLOT:SELect <Slot>

This command selects the slot to analyze.

Parameters:
<Slot> **S0**
Slot 0
S1
Slot 1
ALL
Both slots
*RST: ALL

Example: `SLOT:SEL S1`
Selects slot 1 for analysis.

Manual operation: See "Slot Selection" on page 88

[SENSe][:LTE]:SUBFrame:SELect <Subframe>

This command selects the subframe to be analyzed.

Parameters:
<Subframe> ALL | <numeric value>
ALL
Select all subframes
0...39
Select a single subframe
*RST: ALL

Example: `SUBF:SEL ALL`
Select all subframes for analysis.

Manual operation: See "Subframe Selection" on page 87

[SENSe][:LTE]:SYMBol:SELect <Symbol>

This command filters the displayed results in the constellation diagram by a particular OFDM symbol.

Parameters:

<Symbol>

ALL
Shows the results for all subcarriers.

<numeric_value>
Shows the results for a particular OFDM symbol.

*RST: ALL

Example:
```
SYMB:SEL 2
```
Shows the results for the second OFDM symbol.

Manual operation: See "Evaluation Range for the Constellation Diagram" on page 88

6.11.2 Y-Axis Scale

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO ONCE

Automatic scaling of the y-axis is performed once, then switched off again (for all traces, <t> is irrelevant).

Usage: SCPI confirmed

Manual operation: See "Y-Axis Scale" on page 89

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum <Value>

This command defines the maximum value of the y-axis for all traces in the selected result display.

The suffix <t> is irrelevant.

Parameters:

<Value>

<numeric value>

*RST: depends on the result display
The unit and range depend on the result display.

Example:
```
DISP:TRAC:Y:MIN -60
DISP:TRAC:Y:MAX 0
```
Defines the y-axis with a minimum value of -60 and maximum value of 0.

Manual operation: See "Y-Axis Scale" on page 89

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum <Value>

This command defines the minimum value of the y-axis for all traces in the selected result display.

The suffix <t> is irrelevant.

Parameters:

<Value> <numeric value>

*RST: depends on the result display

The unit and range depend on the result display.

Example:

```
DISP:TRAC:Y:MIN -60
DISP:TRAC:Y:MAX 0
```

Defines the y-axis with a minimum value of -60 and maximum value of 0.

Manual operation: See "Y-Axis Scale" on page 89

6.11.3 Result Settings

CALCulate:MARKer:COUPling <State>

This command couples or decouples markers in different result displays to each other.

Parameters:

<State> ON | OFF

Example:

```
CALC:MARK:COUP ON
```

Couples the markers to each other.

Manual operation: See "Marker Coupling" on page 91

UNIT:BSTR <Unit>

This command selects the way the bit stream is displayed.

Parameters:

<Unit>

SYMbols
Displays the bit stream using symbols

BITs
Displays the bit stream using bits

*RST: SYMbols

Example:

```
UNIT:BSTR BIT
```

Bit stream gets displayed using Bits.

Manual operation: See "Bit Stream Format" on page 90

UNIT:CAXes <Unit>

This command selects the scale of the x-axis for result displays that show subcarrier results.

Parameters:

<Unit>

CARR
Shows the number of the subcarriers on the x-axis.

HZ
Shows the frequency of the subcarriers on the x-axis.

Example: `UNIT:CAX HZ`
Selects frequency scale for the x-axis.

Manual operation: See "Carrier Axes" on page 90

UNIT:EVM <Unit>

This command selects the EVM unit.

Parameters:

<Unit>

DB
EVM results returned in dB

PCT
EVM results returned in %

*RST: PCT

Example: `UNIT:EVM PCT`
EVM results to be returned in %.

Manual operation: See "EVM Unit" on page 90

List of Commands

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